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ENGINEERING BUILDING

LAKELAND, FLORIDA

DESIGN CRITERIA

REFERENCE SPECIFICATIONS

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SECTION 011000 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Division 1 specifications are to be developed based on Florida Polytechnic Universities Standards and Owner project requirements. The specifications listed here in are reference specifications based on the Applied Research Center (ARC) basis of design approach.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 022100 – GROUND MODIFICATION VIBROREPLACEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 DESCRIPTION OF WORK:

A. This Section includes ground modification vibroreplacement work indicated on the drawings and in the Geotechnical Report.

B. Basis of Bidding shall include the sum for all this work to be a part of the Contract Price based on given values as stated herein and the work indicated. The lump sum amount may be adjusted on basis of Unit Prices stated in the Proposal Form for work actually performed and materials in place.

C. The proposed work consists of ground modification by the vibroreplacement method.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Vibroreplacement Probe Plan: The Specialty Sub-Contractor shall submit a vibroreplacement Probe Plan defining the probe pattern spacing and depths and the specifications of the type of equipment to be used.

C. Special Backfill: Provide name of source or sources of special backfill materials proposed for the project.

D. Specialty Subcontractor: Provide complete qualification data to establish qualifications of the Contractor proposed for the work of this Section.

E. Samples - Special Backfill: Provide as requested.

F. Reports: Reports of all work and material in place prepared by the Geotechnical Engineer, any required tests and initialed copies of fill material delivery slips.

1.4 QUALITY ASSURANCE

A. Specialty Subcontractor Qualifications: The work shall be performed by a Contractor specializing in ground improvement by vibroreplacement. The Contractor shall establish, to the satisfaction of the Engineer, that he is an experienced specialty contractor that has completed at least five projects of similar scope and purpose.

B. Geotechnical Engineer: The Owner shall provide the services of a qualified geotechnical engineer during the performance of work of this Section to monitor the work and prepare written reports of all work and material in place. In addition, the geotechnical engineer shall be provided with copies of special backfill material delivery slips to be initialed by him and to be made part of "Submittals" specified herein.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment used shall be of a type, capacity, and mechanical condition suitable for doing the work. All equipment shall be maintained in first-class operating condition at all times.

B. Special Backfill Material:
   1. Sand Backfill: Granular backfill shall be clean sand containing no more than 10 percent fines, by weight, passing the No. 200 sieve.
   2. Rock Backfill: Rock backfill shall consist of No. 57 stone or approved material of similar gradation.
   3. Combination of Sand and Rock Backfill shall be determined by the Specialty Contractor but shall be approved by the Geotechnical Engineer.

PART 3 - EXECUTION

3.1 PROCEDURES

A. The probe shall be provided at locations indicated on the Vibroreplacement Probe Plan. Each probe shall be inserted to at a depth below grade as determined by the vibro-replacement delegated engineer.

B. Backfill shall be added and compacted as necessary to fill any voids encountered.

C. Vibroreplacement Technique:
   1. Vibroreplacement is a process in which the subsurface soils are compacted by a vibrating probe inserted into the ground.
   2. The vibroreplacement probe is called a "vibroflot". Typically, the vibroflot shall be jetted and vibrated to the specified level and then slowly withdrawn. During withdrawal of the vibroflot, crushed stone or gravel and clean sands shall be piled around the probe and worked downward into the annulus between the vibroflot and the natural soils.
   3. Primary Objective of the ground modification at this site is to achieve a bearing capacity of at least 6000 psf under the columns and wall footings.

3.2 BASIS OF BID

A. The lump sum amount for work under this Section shall be based upon the following:
   1. The work includes vibroreplacement probes at location and depths indicated and shall include all required equipment, material, labor and all else necessary to complete work.

END OF SECTION 022100

SECTION 031000 – CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. Section includes formwork, shoring, reshoring, backshoring, falsework, bracing, and other temporary supports required to form and support all cast-in-place concrete shown on the drawings.

B. Related Requirements:
1. Specification 014000 “Quality Requirements” for requirements of material testing and inspection.
2. Specification 014529 “Structural Testing and Inspections” for inspection requirements associated with forming and accessories.
3. Specification 032000 “Concrete Reinforcing” for reinforcement associated with cast-in-place concrete.
4. Specification 033000 “Cast-in-Place Concrete” for cast-in-place concrete and related products.

1.3 REFERENCES

A. Definitions:
1. Backshores: Shores placed snugly under a stripped concrete structural member after the original formwork and shores have been removed from a small area <u>without</u> allowing the structural member to deflect or support its own weight or superimposed construction loads. It is assumed that backshores carry the same load as that carried by the original shores they replace.
2. Formwork: The total system of support for freshly placed concrete, including the mold or sheathing that contacts the concrete and all supporting members, hardware, and necessary bracing.
3. Professional Engineer: A professional engineer who is licensed to practice engineering in the state where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with concrete formwork that are similar to that indicated for this Project in material.
4. Reshores: Shores placed snugly under a stripped concrete structural member <u>after</u> the original forms and shores have been removed from the member, thus requiring the member to carry its own weight and superimposed construction loads at the time of installation. Reshores are assumed to carry no load at the time of installation. After the installation of reshores, superimposed construction loads are assumed to be distributed among all members connected by reshores.
5. Shores: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.

B. Reference Standards:
   1. Comply with the provision of the following codes, specifications, and standards except where more stringent requirements are shown or specified:
      a. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
      b. ACI 301, "Specifications for Structural Concrete for Buildings."
      c. ACI 318, "Building Code Requirements for Structural Concrete."
      d. ACI 347, “Guide to Formwork for Concrete.”
      e. ACI 347.2, “Guide for Shoring/Reshoring of Concrete Multistory Buildings.”
      f. CRSI, "Manual of Standard Practice."

1.4 RESPONSIBILITY

A. The design, construction, and safety of all formwork shall be the responsibility of the Contractor. All forms, shores, reshores, backshores, falsework, bracing, and other temporary supports shall be engineered to support all loads imposed including the wet weight of concrete, construction equipment, live loads, lateral loads due to wind and wet concrete imbalance. The Contractor shall also be responsible for determining when temporary supports, shores, reshores, backshores, and other bracing may be safely removed.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Formwork Drawings: Formwork drawings, prepared under the supervision and sealed by the formwork design engineer, shall be submitted for Owner’s record and shall be reviewed by the Engineer for conformance to structural layout only. Such shop drawings shall indicate all dimensions and types of materials, sizes, lengths, connection details, design allowance for construction loads, anchors, form ties, shores, braces, construction joints, reveals, camber, openings, formwork coatings, and all other pertinent information.

B. Temporary Structure Design Submittals: Submit the following items for the Owner’s records:
   1. Design Calculations: Submit, for record purposes, calculations of all concrete formwork sealed by the formwork design engineer.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Licensed Professionals: The formwork design engineer retained by the Contractor shall be a professional engineer registered in the state where the project is located and shall be experienced in the design of concrete formwork.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Non-specific formed concrete: Unless otherwise specified, the default finish for formed surfaces shall be rough-form finish constructed with plywood, lumber, metal, or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit. The minimum grade shall be B-C, exterior grade.

B. Textured-form finished concrete: For exposed surfaces as noted on the drawings provide units of form face design, size, arrangement and configuration that matches Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners. See Architect's drawings, specifications and control sample for special form textured finish concrete.

2.2 FORMWORK COATINGS

A. Formwork coatings shall be of a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces or impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede curing with water or curing compounds. Provide a product that has a maximum VOC (Volatile Organic Compounds) of 50 g/l but not greater than that permitted by the local government agency having jurisdiction in the area where the project is located.

B. Products: Subject to compliance with requirements, provide one of the following:
   1. Dayton Superior; Bio-Release EF.
   2. Unitex; Farm Fresh.
   3. Universal Form Clamp; Bio-Form.
   4. US Spec; Aqua Blue.

2.3 NAILS AND FASTENERS

A. Use only galvanized nails and fasteners for securing formwork in structures exposed to weather or unconditioned spaces such as garages, canopies, and porte-cocheres.

2.4 FORM TIES

A. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to minimize spalling of concrete on removal.
   1. Exposed Surfaces: For surfaces designated with Surface Finish Class SF-2.x or SF-3.x, furnish units that will leave no portion of the tie closer than 3/4 inch to the plane of the concrete surface and that will leave holes not larger than one inch in diameter in concrete surface when the ends or end-fasteners have been removed.
   2. Dampproofed Surfaces: Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
   3. Exposed to Weather or Unconditioned Space: Provide removable, glass-fiber-reinforced plastic, stainless steel, or galvanized form ties that will leave no corrodible metal closer than 1 1/2 inches in surfaces that will be exposed to weather or in an unconditioned space in the final structure. The ties shall leave holes no larger than one inch in diameter in concrete surfaces when the ends or end-fasteners are removed.

2.5 CHAMFER STRIPS

A. Provide wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

PART 3 - EXECUTION

3.1 FABRICATION AND CONSTRUCTION

A. Design, erect, support, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic construction loads that might be applied until the concrete structure can support such loads.
   1. The formwork design engineer shall design the concrete formwork, formwork removal, shoring, reshoring, and backshoring.

B. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of concrete mortar.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

D. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and patch forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using specified chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

3.2 CLEANING AND TIGHTENING

A. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and all other debris just prior to concrete placement. Retighten forms and bracing prior to concrete placement as required to prevent concrete mortar leaks and maintain proper alignment.

3.3 CLEANING AND RE-USE OF FORMS

A. Forms reused in the work shall be repaired and cleaned. Split, frayed, delaminated, or otherwise damaged facing material will not be acceptable for exposed surfaces. Forms intended for successive concrete placement shall have surfaces cleaned, fins and laitance removed, and joints tightened to avoid surface offsets. New form coating compound shall be applied to reused forms.

Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.4 TOLERANCES

A. Unless specified otherwise, all tolerances for concrete formwork shall conform to ACI Standard 117, "Standard Tolerances for Concrete Construction and Materials". Before concrete placement the Contractor shall check lines and levels of erected formwork and make any corrections and adjustments as required to ensure proper size and location of concrete members and stability of forming systems. During concrete placement the Contractor shall check formwork and supports to ensure that forms have not displaced and that completed work will be within specified tolerances.

B. Construct forms so as to limit the offset between adjacent pieces of formwork facing material in accordance with the surface tolerance class as defined in ACI 117 corresponding to the Surface Finish Class noted on the drawings. The offset limits shall apply to both abrupt and gradual variations in the surface.

C. Prior to each concrete pour, the Contractor shall engage a qualified surveyor to verify that work is within specified tolerances. The surveyor shall report in writing to the Architect, Engineer and Contractor certifying that the work is acceptable or indicating any deviations from allowable tolerances.

3.5 SHORES AND SUPPORTS

A. Comply with requirements of ACI 301 for shoring, reshoring and backshoring in concrete construction and as herein specified where more stringent.

B. Design: Shores and reshores or backshores must be designed to carry all loads transmitted to them. A rational analysis should be used to determine the number of floors to be shored, reshored, or backshored, subject to the minimums stated in the following paragraph, and to determine the loads transmitted to the floors, shores and reshores or backshores as a result of the construction sequence. The analysis should consider, but should not necessarily be limited to, the following:
   1. Structural design load of the slab or member including live load, partition loads, and other loads for which the engineer designed the slab. The live load reduction method for the design of certain members is shown on the structural drawings. The reduced live load and an allowance for construction loads shall be taken into consideration when performing the analysis.
   2. Dead load weight of the concrete and formwork.
   3. Construction live loads, such as placing crews and equipment or stored materials.
   4. Design strength of concrete specified.
   5. Cycle time between placement of successive floors.
   6. Strength of concrete at time it is required to support shoring loads from above.
   7. The distribution of loads between floors, shores, and reshores or backshores at the time of placing concrete, stripping formwork, and removal of reshoring or backshoring.
   8. Span of slab or structural member between permanent supports.

9. Type of formwork systems, i.e., span of horizontal formwork components, individual shore loads, etc.
10. Minimum age of concrete where appropriate.
11. Alignment of shores: Where possible, shores for any floor shall be placed directly above previously placed shores so that load will be transferred directly to such shores. Where shores are not vertically aligned, calculations shall include verification that the structure can support the reaction.

3.6 REMOVAL OF FORMS AND SUPPORTS

A. Determination by Contractor's Registered Engineer: The Contractor's registered professional engineer shall determine and submit for Owner's record the time and sequence of formwork and shore removal subject to the criteria as specified below. The submittal shall clearly distinguish between reshoring and backshoring procedures.

B. Determining in situ Strength of Concrete: The General Contractor shall be responsible for making and curing concrete cylinders, cured under field conditions, for the purpose of determining concrete strength at time of form and shore removal. Such cylinders shall be made by the Contractor and tested by his testing laboratory. Alternatively, the in situ strength of concrete may be determined by the Maturity Method following the requirements of ASTM C 1074. An acceptable system for this method is the “intelliRock” system manufactured and supplied by Engius Constructive Intelligence of Stillwater, OK.

C. Records of Weather Conditions: The Contractor shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms.

D. Formwork Not Supporting Concrete: Formwork not supporting concrete, such as sides of beams, walls, columns and similar parts of the structure, may be removed after cumulatively (not necessarily consecutively) curing at not less than 50°F for 12 hours after placing concrete, provided the concrete is sufficiently hard so as not to be damaged by form removal operations and provided curing and protection operations are maintained. If ambient air temperatures remain below 50°F, if retarding agents are used, or if Type II and Type V Portland cement is used, then this specified minimum period shall be increased as required to safely remove the forms without damage to the concrete. Where such forms also support formwork for slab or beam soffits, the removal times of the latter shall govern.

E. Formwork Supporting Weight of Concrete: Formwork supporting weight of concrete such as beam soffits, joists, slabs and other structural elements shall not be removed until concrete has attained at least the following percentages of the design compressive strength:
1. Joists, Beam Bottoms: 70%, but not less than 2,800 psi.
2. Slabs: 70%, but not less than 2,800 psi.

F. Placing Reshores and Backshores:
1. All shoring operations shall be carried out in accordance with a planned sequence as determined by the Contractor's shoring engineer.
2. Shoring operations shall be performed so that at no time will areas of new construction be required to support combined dead and construction loads in excess of the available strength as determined by the design loads (as specified in the General Notes) and the developed concrete strength (as determined by field cured cylinders or maturity method) at the time of stripping and reshoring or backshoring.
3. Shores (backshores or reshores) shall not be removed until the structural member supported has sufficient strength to support all applied loads.

4. For backshoring operations, the forms shall be removed in such a manner that individual structural members are not allowed to deflect and carry load.
5. Reshoring operations require that the structural members be strong enough to safely support their own weight before stripping of formwork.
6. For reshoring operations, no structural member shall be overstressed under its own dead weight plus the weight of the floors above and construction loads assigned to the structural member by a rational analysis that accounts for the relative stiffness of each floor with due consideration of concrete age and strength. While reshoring is underway, no construction loads shall be permitted on the new construction unless it can safely support the construction loads.
7. Where possible, shores shall be located in the same position on each floor so that they will be continuous in their support from floor to floor.

3.7 FIELD QUALITY CONTROL

A. Field Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for inspection requirements associated with forming and accessories.

END OF SECTION 031000

SECTION 032000 – CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. Section includes labor, materials, hardware, equipment, transportation and services required to fabricate and place all reinforcement for cast-in-place concrete including bars, welded wire reinforcement, ties and supports shown on the drawings and as specified.

B. Related Requirements:

1. Specification 014000 “Quality Requirements” for requirements of material testing and inspection.

2. Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with concrete reinforcing.
3. Specification 031000 “Concrete Forming and Accessories” for forming associated with cast-in-place concrete.
4. Specification 033000 “Cast-in-Place Concrete” for cast-in-place concrete and related products.

1.3 PRICE AND PAYMENT PROCEDURES

A. Alternates:

1. Products Requiring International Code Council (ICC) Evaluation Service Reports:

a. For those products listed in Part 2 as requiring Evaluation Service Reports (ESRs), alternate products that do not have ESRs will be considered by the Engineer only if valid research reports or test data from an independent and approved agency is provided and use of the product receives prior approval from the Building Official.

1.4 REFERENCES

A. Reference Standards:

1. Comply with all provisions of the following codes, specifications, and standards except where more stringent requirements are shown or specified:

a. ACI 117, “Specifications for Tolerances for Concrete Construction and Materials."

b. ACI 301, "Specifications for Structural Concrete for Buildings."
c. ANSI/AWS D1.4, “Structural Welding Code – Reinforcing Steel.”
d. CRSI, "Manual of Standard Practice."

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Quality Control: The Contractor is responsible for quality control, including workmanship and materials furnished by subcontractors and suppliers.
2. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

B. Preinstallation Meetings: The Reinforcing-Placing subcontractor and Fiber Reinforcement Representative shall attend the Pre-Concrete Conference conducted by the Concrete Contractor as described in Specification 033000 “Cast-in-Place Concrete.”

1.6 SUBMITTALS

A. Product Data: Submit manufacturer’s product data with application and installation instructions for proprietary materials and items including hooked anchorage systems, dowel bar replacement systems, and dowel bar sleeves. For fiber reinforcement, submit manufacturer’s product data, including application rate and mixing instructions.

B. Shop Drawings:

1. Submit shop drawings for all reinforcing steel and related accessories for the Engineer's approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards.

C. Certificates:

1. Submit, for record, mill certificates and/or test results signed by Producer, for all reinforcement.
2. Provide certification from fiber reinforcement manufacturer that fiber reinforcement complies with specified requirements.

D. Test and Evaluation Reports:

1. Submit International Code Council (ICC) Evaluation Service Reports indicating approval from ICC Evaluation Service, Inc. for hooked anchorage systems and dowel bar replacement systems.

E. Qualification Statements: Submit welding certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Reinforcement:

1. Reinforcing materials shall be delivered from the mill in bundles that are identified as to heat number and manufacturer and accompanied with mill and analysis test reports and an affidavit from the supplier stating that the material conforms to the requirements of the governing ASTM specification listed herein.
2. are not required for #14 and #18 bars. Submit the results of such tests for record.
3. Reinforcing Bars: Reinforcing bars shall conform to ASTM A 615, Grade 60 or as noted on the drawings.
4. Reinforcing Steel: Reinforcing steel used as transverse reinforcing or as spiral reinforcing as noted on the drawings shall conform to ASTM A 1035.
5. Weldable Reinforcing Bars: All reinforcing bars noted on the drawings as being required to be welded shall conform to ASTM A 706, Grade 60.
6. Deformed Bar Anchors: 3/8” to 5/8” diameter AWS Type C studs manufactured in conformance with ASTM A 1064 with a minimum yield strength of 70,000 psi and a tensile strength of 80,000 PSI. 3/4" or larger diameter, ASTM A 706 bars of equal size with welds to steel substrate that develop the full strength of the anchor. ASTM A 615 reinforcing bars may not be substituted for deformed bar anchors. Reinforcement shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review. The following are acceptable products, provided that their Evaluation Service Reports are still valid at the time of intended use on the project:
   a. Nelson Stud Welding, Inc.; Nelson D2L Deformed Bar Anchor Studs (ESR-2907).
   b. Tru-Weld Division, TFP Corporation; Deformed Bar Anchors (ESR-2823).
7. Plain Steel Welded Wire Reinforcement: ASTM A 1064 with a yield strength of 65,000 PSI. Provide in flat sheets only.
8. Deformed-Steel Welded Wire Reinforcement: ASTM A 1064 with a yield strength of 70,000 PSI. Provide in flat sheets only.
9. Wire: Smooth wire for spiral reinforcement shall conform to ASTM A 82 with a minimum yield strength of 70,000 PSI.

B. Fiber Reinforcement:

1. Synthetic Micro Fiber Reinforcement: Collated, fibrillated, or monofilament polypropylene, cellulose, or multi-filament nylon fibers conforming to ASTM C 1116, Type III or Type IV. Reinforcement shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review. The following are acceptable products, provided that their Evaluation Service Reports are still valid at the time of intended use on the project:

   a. The Euclid Chemical Company; Fiberstrand Series.
   b. Forta Corporation; Econo-Mono or Econo-Net (ESR-2720).
   c. Propex Concrete Systems Corp.; Fibermesh 300 (ESR-1165).
   d. W.R. Grace & Company; Grace Microfibers (ESR-1506).
   e. Nycon, Inc.; Nycon RC.
   f. Buckeye Technologies; UltraFiber 500 (ESR-1032).
   g. BASF Construction Chemicals; MasterFiber M or F series.
   h. Maccaferri; Fibromac.

2. Synthetic Macro Fiber Reinforcement: Monofilament polypropylene/polyethylene fibers conforming to ASTM C 1116, Type III having an aspect ratio between 50 and 90 and a minimum tensile strength of 90 KSI. The fiber lengths shall be between 1.5 and 2 inches long. Reinforcement shall be approved by the ICC-Evaluation Service, Inc. and shall have the Evaluation Service Report submitted for Engineer review. The following are acceptable products, provided that their Evaluation Service Reports are still valid at the time of intended use on the project:

    a. The Euclid Chemical Company; Tuf-Strand SF.
    b. Forta Corp.; Forta-Ferro.
    c. W.R. Grace; Strux 90/40.
    d. Propex Concrete Systems, Corp.; Fibermesh 650.
    e. Bekaert Corp.; Synmix.
    f. BASF Construction Chemicals; MasterFiber MAC.

3. Steel Fibers: Provide deformed cold-drawn wire or modified cold-drawn steel fibers meeting the requirements of ASTM A 820, Types I or V, and that are listed as an acceptable product for use in the D900 series of UL Fire Rating Assemblies. The fibers shall have a minimum tensile strength of 145,000 PSI when tested in accordance with ASTM A 370. The fibers shall have a minimum aspect ratio of 50 and maximum aspect ratio of 100. Acceptable products include:

    a. Bekaert Corp; Dramix 3D 65/60 BG (Type 1), or Dramix 3D 80/60 BG (Type 1).
    b. Propex Concrete Systems, Corp.; Novocon 1050 (Type I), Novocon 1050 HE (Type I), or Novomesh 850 (Type I).
    c. BASF Construction Chemicals; MasterFiber FF or FS series.
    d. Maccaferri; Wirand series.

2.2 SPLICES

A. Mechanical Tension Splices:

1. Mechanical splices shall conform to Type 1 splices.

    a. Type 1 splice shall develop, in tension and compression, 1.25 times the specified yield strength of the splice bar.

2. Splices shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review.
3. The bar ends that are to attach to the splice shall be prepared and installed in accordance with the manufacturer's requirements.
4. The following are acceptable mechanical tension splices (splices qualified for use with grade 75 bars are parenthetically noted), provided that their Evaluation Service Reports are still valid at the time of intended use on the project:

    a. BarSplice Products, Inc.; BPI-Grip XL System (ESR-2299). (Type 1 or Type 2)
    b. BarSplice Products, Inc.; Taper Threaded Grip-Twist System (ESR-2299). (Type 1 or Type 2)
    c. BarSplice Products, Inc.; Position Taper Threaded Grip-Twist System (ESR-2299). (Type 1 or Type 2)
    d. Headed Reinforcement Corporation; HRC 500/510 Xtender Mechanical Coupler System (ESR-2764). (Type 1 or Type 2)

B. Dowel Bar Replacement: All grade 60 reinforcing steel dowel bars shown on the drawings crossing concrete construction joint surfaces with inserts cast flush against the form and having reinforcing bars connected to the insert in a subsequent concrete pour shall conform to the following:

1. Splice connection to the insert shall develop the 1.25 times the specified yield strength and the full tensile strength of the spliced bar.
2. Splices shall be approved by the ICC Evaluation Service, Inc. as expressed in an ICC Evaluation Service Report which shall be submitted for review.
3. The following are acceptable products (for use only with grade 60 bars), provided that their Evaluation Service Reports are still valid at the time of intended use on the project:

   a. Dextra Manufacturing Co., Ltd.; Bartec Mechanical Splice System for Steel Reinforcing Bars in Concrete (ESR-1705).

C. Hooked Anchorage Replacement: Reinforcing bar terminations shall be manufactured out of ASTM A 576, ASTM A 615, or A 706 material and shall develop the full tensile strength of the bar when installed at the manufacturer's recommended depth.

1. The anchorage shall be approved by the ICC Evaluation Service Inc. as expressed in an ICC Evaluation Service Report which shall be submitted for review.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: Smooth bars used to dowel across slab-on-grade construction joints shall conform to ASTM A 615, Grade 40 or ASTM A 36, plain-steel bars. Cut bars true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: Smooth epoxy-coated bars used to dowel across slab-on-grade construction joints shall conform to ASTM A 775 with ASTM A 615, Grade 40 or ASTM A 36 plain-steel bars. Cut bars true to length with ends square and free of burrs.

C. Dowel Bar Sleeves: Plastic or gage metal (26 gauge minimum) sleeves with an inside diameter of 1/16 inch greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.

D. Alternate Slab-on-Grade Joint Load Transfer Systems: A system that consists of flat, ASTM A 36 plate that is saw cut into a square or rectangular shape and is embedded into or encased by a plastic sleeve that allows movement in both lateral directions but not in the vertical direction. Acceptable systems are manufactured by PNA Construction Technologies with products known by the names "Diamond Dowel System" and "PD^3 Basket" and Greenstreak Group Inc. with products known as "Speed Plate' and "Double-Tapered Basket".

E. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge.

   a. Tie wire in architecturally exposed concrete shall be plastic coated or stainless steel.
   b. Tie wire for epoxy-coated reinforcement shall be epoxy-coated.
   c. Tie wire for galvanized reinforcement shall be galvanized.

F. Holding Wire: Holding wire shall conform to ASTM A 82 or ASTM A 1064.

G. Coating Repair Materials: Repair damaged areas of epoxy-coated or galvanized reinforcement using the following products.

1. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating compatible with epoxy coating on reinforcement and complying with ASTM A 775.
2. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc shall be used to repair damaged areas of galvanized reinforcement.

H. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Use wire bar type supports complying with CRSI recommendations.

1. Slabs-on-Grade: Use precast concrete bar supports (dobies) or supports with sand plates or horizontal runners designed for use on ground.
2. Spread Footing Bottom Reinforcement: Use precast concrete bar supports (dobies) or chairs designed for soil-supported slabs.
3. Mat Foundation: Use precast concrete bar supports (dobies), chairs designed for soil-supported slabs, or cast-in-place concrete curbs.
4. Exposed to View Concrete: Provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
5. Support of Epoxy-Coated Reinforcement: Provide epoxy-coated or other dielectric-polymer-coated wire bar supports to support epoxy-coated reinforcement.
6. Support of Galvanized Reinforcement: Provide galvanized wire bar supports to support galvanized reinforcement.

PART 3 - EXECUTION

3.1 FABRICATION AND DELIVERY

A. Bending and Forming: Fabricate bars of indicated sizes and accurately form to shapes and lengths indicated and required, by methods not injurious to materials. Do not heat reinforcement for bending. Bars shall be free from injurious defects, have a workman-like finish with no excessive rust and/or pitting, and have no unusual kinks or bends.

B. Marking and Shipping: Bundle reinforcement and tag in accordance with Section 7.4.5 of the CRSI “Manual of Standard Practice.” Transport and store at site so as not to damage material. Keep sufficient supply of tested, approved, and proper reinforcement at the site to avoid delays. Maintain reinforcing bars free of mud, dirt, grease, or other coating.

C. Repair of Epoxy-Coated Reinforcing: Repair cut and damaged epoxy coatings on fabricated reinforcing before delivery with epoxy repair coating according to ASTM D 3963

3.2 PLACING REINFORCEMENT

A. Comply with CRSI recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as herein specified.

B. Before placing reinforcement and again before concrete is placed, clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by chairs, runners, bolsters, spacers, and hangers as required. Exercise particular care to maintain proper distance and clearance between parallel bars and between bars and forms. Provide spreaders and spacers to hold steel in position. Support steel at proper height upon approved chairs.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set tie wires so ends are directed into concrete, not toward exposed concrete surfaces.

E. Support of Spread Footing Reinforcing Steel:

1. Bottom Steel: Support bottom reinforcing mat to provide the specified clearance to the bars. Spacing between supports shall not exceed 4'-0" centers each way.
2. Top Steel: Support top reinforcing on steel angle frames braced in both directions or on special standee support bars. Spacing between supports shall not exceed 4'-0" centers each way. The depth of the supports shall provide the specified clearance from the bars to the top of the concrete. The design of the support steel shall be the responsibility of the Contractor.

F. Install welded wire reinforcement in as long lengths as practicable. Provide lap splice for wires of adjoining pieces per ACI 318 Chapter 12.18.1 or 12.19.1 and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

G. Coordinate with other trades and expedite materials and labor to avoid omissions and delay.

H. Install waterproof membrane or vapor retarder as specified prior to placing steel for concrete slabs-on-grade.

I. Extend reinforcement continuous through construction joints unless otherwise shown on the drawings.

J. Slab-on-Grade Joint Dowel Bars: Support slab-on-grade joint dowel bars independently of support for slab reinforcement on soil supported slab bolsters or specially manufactured cradles such that dowel bar remains parallel to slab surface and at right angles to joint during concreting operations. Lightly coat the exposed end of the dowel with a paraffin-base lubricant, asphalt emulsion, form oil, or grease or use a dowel bar sleeve.

K. Alternate Slab-on-Grade Joint Load Transfer Systems: Install the alternate load transfer system in accordance with the manufacturer’s instructions such that the largest plane of the flat plate is parallel to the plane of the subgrade on which the slab is bearing.

L. Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs, and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide required additional reinforcing steel at no additional cost to the Owner.

M. Do not bend reinforcement that is embedded partially in concrete except in locations noted on the drawings or approved by the Engineer.

3.3 SPLICING REINFORCING STEEL

A. Provide splices as indicated on the drawings. Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted.

B. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.

C. Maintain proper cover and spacing between reinforcing bars at splices.

D. Lap unscheduled reinforcing bars not otherwise specified with a Class B lap splice. Lap welded wire reinforcement per ACI 318 Chapter 12.18.1 or 12.19.1.

E. Manufacturer of mechanical tension splice shall be present for first day's installation.

3.4 WELDING REINFORCING STEEL

A. Welding reinforcing steel is permitted only where specifically shown on the drawings. All welding shall conform to AWS D1.4. Only weldable reinforcing steel conforming to ASTM A 706 or deformed bar anchors conforming to ASTM A 1064 shall be permitted. ASTM A 615 bars may <u>not</u> be welded for structural use.

B. Tack welding of reinforcement shall not be permitted.

C. Fusion welding of preassembled cages shall be permitted only under the following conditions:
   1. Written approval is received from the Building Official and the Engineer.
   2. Fusion welding of holding wires to ties, stirrups, and hoops in beams, columns and grade beams to preassemble reinforcing cages is permissible. The holding wire area shall not exceed five percent of the beam, column, or grade beam cross sectional longitudinal steel area. Fusion welding is not allowed to longitudinal reinforcing steel in any beam, column, or grade beam.
   3. Fusion welding of holding wires to the ends of the reinforcing steel placed in spread footings or mats is permitted if the fusion weld occurs within six bar diameters of the free end of the bar. Fusion welding is not allowed at the end of coupled, T-headed, or weld spliced bars.
   4. Fusion welding of holding wires shall not occur on a bent portion of a reinforcing bar. Bars shall not be bent where a fusion weld occurs.

3.5 SHRINKAGE AND TEMPERATURE REINFORCEMENT

A. Provide shrinkage and temperature reinforcement as indicated on the drawings at right angles to main top and bottom bars for all structural slabs unless detailed otherwise on the drawings.

3.6 PLACEMENT OF WELDED WIRE REINFORCEMENT

A. Wherever welded wire reinforcement is specified as reinforcement in pan-formed beams or slabs, it shall be continuous and properly lapped per ACI 318 Chapter 12.18.1 or 12.19.1 across the entire concrete surface and not interrupted by beam or girders.

3.7 REINFORCEMENT IN COMPOSITE STEEL DECK SLAB

A. Composite steel deck slabs shall be reinforced as indicated on the drawings.

B. Extra Reinforcement over Girders: Provide additional reinforcing steel over interior girders as shown on the drawings.

C. Placement of Slab Reinforcement: Provide bolsters, high chairs, and/or additional reinforcing as shown in details on the drawings to support the reinforcing with the clear cover shown on the drawings.

D. Fiber-Reinforced Concrete in Composite Steel Deck Slabs:

1. Provide fibers of the type and at the dosage rate shown on the drawings in concrete cast over composite steel deck.
2. The fiber-reinforced concrete shall be produced in accordance with ASTM C 1116 and have a residual strength of 80 PSI when tested in accordance with ASTM C 1399.

3.8 REINFORCEMENT AROUND OPENINGS IN COMPOSITE STEEL DECK SLABS

A. For all openings in steel deck not framed with structural steel and greater than 10" in width in either direction, provide additional reinforcing steel as shown in details on the drawings.

3.9 REINFORCEMENT IN GRADE BEAMS

A. Provide reinforcing in grade beams as shown on the drawings.

B. Bar Support for Grade Beam Cages: Grade beam bottom steel shall be supported at 5'-0" maximum centers using beam bolsters that provide bottom cover to the reinforcing steel as noted on the drawings. Beam bolsters used shall be designed and manufactured for support on soil.

3.10 REINFORCEMENT IN TOPPING SLABS

A. Provide welded smooth wire reinforcement minimum 6 x 6 W1.4 x W1.4 in all topping slabs unless specified otherwise on the drawings.

3.11 REINFORCEMENT IN HOUSEKEEPING PADS

A. Provide welded smooth wire reinforcement 6 x 6 W2.9 x W2.9 minimum in all housekeeping pads supporting mechanical equipment unless detailed otherwise on the drawings.

3.12 MECHANICAL AND PLUMBING REQUIREMENTS

A. Refer to Mechanical and Plumbing Drawings for concrete requiring reinforcing steel. Such reinforcement shall be furnished as part of the work of this section.

3.13 FIELD QUALITY CONTROL

A. Field Testing and Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with concrete reinforcing.

END OF SECTION 032000

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. Section includes all labor, materials, services, equipment, and hardware required in conjunction with or related to the forming, delivery, and pouring of all cast-in-place concrete work. Concrete paving and walks are specified in Division 32.

B. Related Requirements:
1. Specification 014000 “Quality Requirements” for requirements of material testing and inspection.
2. Specification 014529 “Structural Testing and Inspections” for inspection requirements associated with cast-in-place concrete.
3. Specification 031000 “Concrete Forming and Accessories” for forming associated with cast-in-place concrete.
4. Specification 032000 “Concrete Reinforcing” for reinforcement for cast-in-place concrete.

1.3 PRICE AND PAYMENT PROCEDURES

A. Alternates:
1. Products Requiring International Code Council (ICC) Evaluation Service Reports:
   a. For those products listed in Part 2 as requiring Evaluation Service Reports (ESRs), alternate products that do not have ESRs will be considered by the Engineer only if valid research reports or test data from an independent and approved agency is provided and use of the product receives prior approval from the Building Official.

1.4 REFERENCES

A. Reference Standards:
1. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
   a. ACI 117, “Specifications for Tolerances for Concrete Construction and Materials.”
   b. ACI 301, “Specifications for Structural Concrete.”
   c. ACI 305.1, “Specification for Hot Weather Concreting.”
   d. ACI 318, “Building Code Requirements for Structural Concrete.”
   e. ACI 355.4, “Qualification of Post-Installed Adhesive Anchors in Concrete.”
   f. CRSI, “Manual of Standard Practice.”

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Quality Control: The Contractor is responsible for quality control, including workmanship and materials furnished by subcontractors and suppliers.
   2. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.
   3. Materials and installed work may require testing and retesting, as directed by the governing building code or the Architect/Engineer, at any time during progress of work.
      a. The Contractor shall provide adequate notification to the Owner's Testing Agency of construction operations including the project schedule to allow the Testing Agency to schedule inspections. Failure to notify sufficiently may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.
      b. The Contractor shall cooperate with laboratory personnel, provide access to the work, and provide access to manufacturer's operations.
      c. The Contractor shall make adequate arrangement with the Owner's Testing Agency for inspection of material stockpiles and facilities.
      d. The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
      e. The Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate the required inspections and tests.
      f. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Tests not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See Structural Testing and Inspections section of the Specifications.
   4. Responsibility for Selection and Use of Concrete Admixtures and Chemical Treatments: The Contractor shall be responsible for selecting admixtures and surface treatments that are compatible with the intended use of the concrete including all final surface treatments called for within this or other specifications or on the structural or architectural drawings. The Contractor is responsible for following the manufacturer's instructions for the use of their product including abiding by any limitations placed by the manufacturer on the use of any of its products.

B. Preinstallation Meetings:
   1. Pre-Concrete Conference:
      a. At least seven days prior to beginning concrete work, the Contractor shall conduct a meeting to review the proposed design mixtures and to discuss required methods and procedures to produce concrete construction of the required quality. Also, review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for materials inspection, testing, and certifications. The contractor shall send a pre-concrete conference agenda to all attendees seven days prior to the scheduled date of the conference.
      b. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:
         1) Contractor's Superintendent.

2) Laboratory responsible for the concrete design mix.
3) Laboratory responsible for field quality control.
4) Concrete Subcontractor.
5) Ready-Mix Concrete Producer.
6) Admixture Supplier.
7) Concrete Pumping Contractor.
8) Fiber Reinforcement Representative.
9) Owner's and Architect's/Engineer's Representative.

c. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within five days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:
1) Owner's Representative.
2) Architect.
3) Engineer-of-Record.

d. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least seven days prior to the scheduled date of the conference.

C. Sequencing:
1. Provide for installation of inserts, hangers, metal ties, anchors, bolts, angle guards, dowels, thimbles, slots, nailing strips, blocking, grounds, and other fastening devices required for attachment of work. Properly locate in cooperation with other trades and secure in position before concrete is poured. Do not install sleeves in any concrete slabs, beams, or columns except where shown on the drawings or upon written approval of the Architect/Engineer.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including admixtures, patching compounds, epoxies, grouts, waterstops, joint systems, curing compounds, dry-shake finish materials, hardeners, sealers, joint fillers, and others as requested by Architect/Engineer.

B. Shop Drawings:
1. Construction Joints: Submit drawings of proposed construction joint locations in concrete for slab-on-grade, mat foundations, structural floors, roofs and walls. Submit any additional or changed reinforcing that is required at construction joints that differs from that shown on the drawings.
2. Openings, Sleeves, and Cores: Submit drawings of all openings to be formed, sleeved, cored, or sawcut in cast-in-place elements. Drawings shall indicate size and location of openings, sleeves, or cores.
3. Penetrations in Beams and Joists: Submit drawings locating all horizontal and vertical penetrations in beams and joists. Drawings shall indicate location, size, orientation, and type of penetrations.
4. Embedded Items: Submit drawings showing all items to be embedded in concrete elements, including plates, angles, bolts, and any non-structural items, such as conduit. Drawings shall indicate location, size, orientation, and type of embedded item.
5. Anchor Rods: Submit drawings showing layout and details for steel templates used for placing anchor rods.

C. Samples: Submit samples of materials specified if requested by Architect/Engineer, including names, sources, and descriptions.

D. Certificates:
1. Material and Mill Certificates:

a. Provide material and mill certificates as specified herein and in the Testing Laboratory section of the Specifications. The Manufacturer and Contractor shall sign the material and mill certificates certifying that each material item complies with specified requirements.
b. Provide certification from admixture manufacturers that chloride ion content complies with specified requirements.

E. Design Mixtures: Submit for each concrete mixture as specified herein.

F. Field Quality Control Submittals:
1. Surveys: Submit report certifying that all anchor rods and reinforcing dowels into columns above are in their proper location prior to placing of concrete.

G. Qualification Statements: Submit certifications for adhesive anchor installers.

H. Minutes of Preinstallation Meetings: Submit for review.

1.7 QUALITY ASSURANCE

A. Qualifications:
1. Concrete Supplier: The concrete supplier shall have a minimum of five years of experience in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment. The supplier must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
2. Concrete Contractor: The concrete contractor shall have a minimum of five years of experience with installation of concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful service performance.
3. Adhesive Anchor Installers: The individuals performing the installation of adhesive anchors that are horizontally or upwardly inclined shall be certified in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program.

B. Survey for Anchor Rods and Reinforcing Steel Dowels: The Contractor shall use a qualified licensed professional engineer or licensed land surveyor to lay out the proper location of all embedded anchor rods and reinforcing steel dowels for columns above before they are encased in concrete. The surveyed locations of such elements shall be submitted to the Architect/Engineer for record, if requested.

C. Manufacturer Representative Presence:
1. Post-installed anchors: The manufacturer's representative for each post-installed anchor product (adhesive, expansion, undercut, screw, or insert anchor) shall be present during the first day's installation of the product to provide instruction for the correct installation of each type of any to be installed in accordance with the manufacturer's recommendation and the current ICC-ES Evaluation Report.
2. Fiber-reinforced concrete: The manufacturer's representative for each fiber type shall be present during the first pour in which the fiber is used to verify whether the dosage rate, placing, and finishing method is in accordance with the specifications and the manufacturer's instruction.

D. Mockups: Provide mock-ups as required.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Refer to the drawings for classes and strengths of concrete required.

B. Hydraulic Cement:
   1. Use ASTM C 150, ASTM C 1157, or ASTM C 595 (excluding Type IS) unless otherwise specified. Do not use Type III cement in slabs-on-grade unless approved in advance by the Engineer.
   2. Concrete Exposed to Sulfates in Soil or Water:
      a. Exposure Class S1: For concrete designated on the drawings as Exposure Class S1, use ASTM C 150, Type II or ASTM C 1157, Type MS.
      b. Exposure Class S2: For concrete designated on the drawings as Exposure Class S2, use ASTM C 150, Type V or ASTM C 1157, Type HS.
      c. Alternate Cement Types for Exposure Classes S1 and S2: ASTM C 150, Type I or III cement may be used for concrete designated as Exposure Class S1 or S2 if the tricalcium aluminate (C_3A) content is less than eight percent for Exposure Class S1 or five percent for Exposure Class S2. ASTM C 150, Type I or III cement may be used for exposure to seawater if the tricalcium aluminate content does not exceed 10 percent and the water/cementitious material ratio of the concrete mix does not exceed 0.40.
      d. Exposure Class S3: For concrete designated on the drawings as Exposure Class S3, use ASTM C 150, Type V plus pozzolan or slag or ASTM C 1157, Type HS plus pozzolan or slag or ASTM C 595, Type IP (HS) or Type IS (HS). The amount of pozzolan or slag added or in a blended mix shall be such that has been determined by service record to improve sulfate resistance when used with Type V cement or the amount that when tested according to ASTM C 1012 meets the criteria of Table 4.5.1 in ACI 318-08.
   3. Use one brand of cement, for each class of concrete, throughout the project, unless approved otherwise by the Architect/Engineer and the Owner's Testing Laboratory. Submit mill certificates certifying conformance to this specification for each brand and type of cement.
   4. Testing of cement in lieu of mill certificate submittal will be required if:
      a. The cement has been in storage at the mixing site for over 30 days.
      b. It is suspected by the Owner, Architect, Engineer, or Owner's Testing Laboratory that the cement has been damaged in storage or in transit or is in any way defective.

C. Low-alkali cement: Cement that has the additional requirement that equivalent alkalis (Na_2O + $0.658K_2O$) do not exceed 0.60% according to ASTM C 150-00, Table 2.

D. Fly Ash: ASTM C 618, Class C or F.

E. Silica Fume: ASTM C 1240, Amorphous Silica.

F. Slag Cement: ASTM C 989, Grade 100 or 120 or ASTM C 595, Type IS or Type S.

G. Normalweight Aggregates: ASTM C 33, and as herein specified. Submit material certificates from aggregate supplier or test results from an independent testing agency certifying conformance to this specification for each source of aggregate.
   1. For concrete identified on the drawings as exposed to Exposure Classes C1 and C2, submit certification that aggregate does not contain any deleterious materials that react with alkalis in the concrete mix to cause excessive expansion of the concrete for concrete

that is exposed to wetting, has extended exposure to humid atmosphere, or is in contact with moist ground unless low-alkali cement is used.

H. Water: Comply with the requirements of ASTM C 1602.

2.2 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. GCP Applied Technologies; Darex or Daravair series.
      b. BASF Corporation; MasterAir VR 10, MasterAir AE 90, MasterAir AE 200.
      c. Sika Corporation; Sika AER.
      d. The Euclid Chemical Company; Air Mix, AEA-92, Eucon Air 30 or Eucon Air 40.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

B. Water-Reducing Admixture: ASTM C 494, Type A. See maximum permissible chloride ion content in concrete specified below.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. BASF Corporation; MasterPozzolith Series.
      b. Sika Corporation; Plastocrete 161.
      c. The Euclid Chemical Company; Eucon WR-75, Eucon WR-91, Eucon NW or Eucon LW.
      d. GCP Applied Technologies; WRDA series, Zyla Series.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

C. Mid-Range Water-Reducing Admixture: ASTM C 494, Type A and Type F. See maximum permissible chloride ion content in concrete specified below.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. BASF Corporation; MasterPolyheed Series.
      b. The Euclid Chemical Company; Eucon MR, Eucon X-15 or Eucon X-20.
      c. Sika Corporation; Sikament HP.
      d. GCP Applied Technologies; Daracem or Mira series.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

D. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G. See maximum permissible chloride ion content in concrete specified below.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. GCP Applied Technologies; ADVA or Daracem Series.
      b. BASF Corporation; MasterRheobuild 1000; MasterGlenium Series, PS 1466.
      c. Sika Corporation; Sikament.
      d. The Euclid Chemical Company; Eucon 37/1037, Plastol series, Eucon SP or Eucon RD2.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

E. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C 494, Type C or E. See maximum permissible chloride ion content in concrete specified below.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. GCP Applied Technologies; Polarset, Lubricon NCA, Daraset 400, or DCI.
      b. BASF Corporation; MasterSet FP 20, MasterSet AC 534.
      c. The Euclid Chemical Company; Accelguard 80/90, Accelguard NCA, or Accelguard AcN.
      d. Sika Corporation; Plastocrete 161FL.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

F. Water-Reducing, Retarding Admixture: ASTM C 494, Type D. See maximum permissible chloride ion content in concrete specified below.
   1. Subject to compliance with requirements, provide one of the following products and manufacturers:
      a. GCP Applied Technologies; Daratard series, or Zyla R.
      b. BASF Corporation; MasterPozzolith R series, or MasterSet DELVO series.
      c. Sika Corporation; Plastiment.
      d. The Euclid Chemical Company; Eucon Retarder series.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

G. Crystalline-Forming Waterproofing Admixture: A powder admixture capable of producing concrete that is water tight under hydrostatic pressure up to seven atmospheres when tested in accordance with Corps of Engineers test CRD-C48 and capable of sealing cracks up to 0.4 mm.
   1. Products: Subject to compliance with requirements, provide the following at dosage rates per manufacturer’s recommendation:
      a. ICS/Penetron International/Ltd; Penetron Admix.
      b. Kryton International, Inc.; Krystol Internal Membrane (ESR-1515).
      c. Xypex Chemical Corporation; Xypex Admix C1000 or C500.
      d. Sika Corporation; Sika WT-215P
      e. BASF Corporation; MasterLife 300D
      f. The Euclid Chemical Company; Eucon Vandex AM-10

H. Calcium Chloride: Calcium chloride is not permitted.

I. Certification: Written conformance to all the above-mentioned requirements and the chloride ion content of the admixture as tested by an accredited laboratory will be required from the admixture manufacturer at the time of design mixture review by the Engineer.

2.3 WATERSTOPS

A. Provide waterstops at all construction joints and other joints in all foundation walls below grade and where shown on the drawings. Size to suit joints.
   1. Products:
      a. Swell Hydrophilic Waterstops:
         1) Manufacturers: GCP Applied Technologies; ADCOR ES.
      b. Polyvinyl Chloride (PVC) Waterstops: Comply with Corps of Engineers CRD-C 572. Provide flat, dumbbell type or centerbulb type as noted on the drawings.
      c. Rubber Waterstops: Comply with Corps of Engineers CRD-C 513. Provide flat, dumbbell type or centerbulb type as noted on the drawings.

d. Preformed Plastic Waterstops: Comply with Federal Specifications SS-S-210A "Sealing Compound for Expansion Joints".
   1) Manufacturers: Henry Corporation; Synko-Flex Waterstop
e. Bentonite Waterstops:
   1) Manufacturers: CETCO; Bentonite Waterstop-RX.

2.4 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate or Aluminum Granule Finish: Provide fused aluminum-oxide granules, or crushed emery, as abrasive aggregate for slip-resistive finish. The emery aggregate shall contain not less than 50% aluminum oxide and not less than 20% ferric oxide. The aluminum aggregate material shall contain not less than 95% fused aluminum-oxide granules. Use material that is factory-graded, packaged, rustproof, and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.
   1. Subject to compliance with requirements, provide one of the following:
      a. Dayton-Superior Corporation, Inc; Emery Non-Slip.
      b. L&M Construction Chemicals, Inc.; Grip-It or Grip-It AO.
      c. BASF Corporation; MasterTop 120SR

2.5 CURING MATERIALS

A. Liquid Membrane-Forming Curing and Curing and Sealing Compounds:
   1. Water-Based Dissipating Resin Type Curing Compound: Curing Compound shall be a dissipating resin type, which chemically breaks down after approximately four weeks. Membrane forming compound shall meet ASTM C 309, Types 1 or 1D, Class B with a VOC content less than 350 grams per liter.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) The Euclid Chemical Company; Kurez DR VOX.
         2) L&M Construction Chemicals; L&M Cure R.
         3) Dayton-Superior Company; Clear Resin Cure J11W.
         4) W.R. Meadows, Inc; 1100-Clear.
         5) US Mix Co.; US Spec Maxcure Resin Clear.
         6) SpecChem LLC; SpecRez.
      b. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments and floor coverings.
   2. High Solids, Water-Based Acrylic Curing and Sealing Compound with Moderate Yellowing Characteristics: Water-Based membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, Class B, classified as low odor with a VOC content less than 350 grams per liter. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, resilient flooring, vinyl-backed carpet, wood, terrazzo, epoxy overlays or adhesives, or other coating or finishing products.
      a. Products: Subject to compliance with above requirements, provide one of the following products or equivalent products:
         1) Dayton-Superior; Cure & Seal 1315 J22WB.
         2) The Euclid Chemical Company; Super Aqua-Cure VOX.
         3) L&M Construction Chemicals; Dress & Seal, 30 WB.
         4) BASF Corporation; Masterkure CC 1315.
         5) SpecChem LLC; Cure & Seal WB 25.
      b. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied.

Submit any instructions that must be followed prior to any subsequent surface treatments.

3. High Solids, Water-Based, Non-Yellowing Curing and Sealing Compound: Water based membrane-forming curing and sealing compound, acrylic type, complying with ASTM C 1315, Type 1, Class A classified as low odor with a VOC content less than 350 grams per liter. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile resilient flooring, vinyl-backed carpet, wood, terrazzo, epoxy overlays or adhesives, or other coating or finishing products.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) The Euclid Chemical Company; Super Diamond Clear VOX.
      2) L&M Construction Chemicals; Lumiseal WB Plus.
      3) BASF Corporation; MasterKure CC 1315.
      4) Dayton-Superior Corporation; Cure & Seal 1315EF
      5) W.R. Meadows, Inc; Vocomp 30.
      6) SpecChem LLC; Cure & Seal WB 30.
   b. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

B. Evaporation Control: Monomolecular film forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss in hot, dry, or windy weather conditions.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. The Euclid Chemical Company; Eucobar.
      b. L&M Construction Chemicals; E-Con.
      c. BASF Corporation; MasterKure ER 50.
      d. Dayton-Superior Corporation; Aqua Film (J74).
      e. Sika Corporation; SikaFilm.
      f. W.R. Meadows, Inc; Sealtight Evapre.
      g. US Mix Co.; US Spec Monofilm ER.
      h. SpecChem LLC; SpecFilm RTU.
   2. Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately nine ounces per square yard, complying with AASHTO M 182, Class 2.

D. Moisture-Retaining Cover: One of the following, complying with ANSI/ASTM C 171:
   1. Waterproof paper.
   2. Polyethylene film.
   3. Polyethylene-coated burlap.
   4. Polyethylene-coated natural cellulose fabric such as Greenstreak Group, Inc.; Aquacure.
   5. Cover for Industrial Slab: Provide a low permeance moisture-retaining cover that allows a moisture loss of no more than one pound per square yard in 72 hours when tested in accordance with ATSM C 156 for industrial slabs. The material shall be non-staining and meet with requirements of ASTM C 171.

2.6 LIQUID FLOOR TREATMENTS

A. Moisture Vapor Reduction Sealer: ASTM C 1315 Type 1 Class A, ASTM C 309 Type 1 Class A, penetrating product to have no less than 34% solids content, leaving no sheen. Acceptable products include:
   1. Creteseal; CS2000 Spray Apply System.

2.7 RELATED MATERIALS

A. Post-Installed Anchors:
   1. Qualified Products:
      a. Mechanical Anchors: Only anchors having passed Acceptance Criteria 193 for use in cracked concrete and resisting wind and seismic loads shall be approved for use. Reports from the following organizations are acceptable:
         1) ICC Evaluation Service Report.
         2) IAPMO Uniform Evaluation Services.
      b. Adhesive Anchoring Systems: Only adhesive anchor systems that comply with the latest revision of ICC-ES Acceptance Criteria 308 for use in cracked concrete and resisting wind and seismic loads shall be approved for use. Reports from the following organizations are acceptable:
         1) ICC Evaluation Service Report.
         2) IAPMO Uniform Evaluation Services.
   2. Alternate Anchor Approval: Install only anchors identified on the drawings by manufacturer and product. Substitutions using products approved by this Specification may be permitted provided complete design calculations are signed and sealed by a registered professional engineer licensed in the state where the project is located and furnished to the Engineer for review and approval prior to commencement of work. The Contractor shall request design criteria for all conditions where a product substitution is considered. Failure to obtain approval for an anchor substitution may result in the request by the Engineer to remove installed anchors and replace with the product specified on the drawings at the Contractor's expense.
   3. Installation: All installation of post-installed anchors shall be in accordance with the Manufacturer's Printed Installation Instructions (MPII).
   4. Interior Use: All anchors for use in interior conditioned environments free of potential moisture shall be manufactured from carbon steel zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.
   5. Exterior or Exposed Use: All anchors for use in exposed or potentially wet environments or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors shall conform to ASTM A 153. Stainless steel anchors shall be manufactured from 300 series stainless steel.
   6. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the anchors.
   7. Anchor Types:
      a. Expansion and Undercut Anchors in Concrete:
         1) Type: All expansion and undercut anchors in concrete shall be wedge type expansion, sleeve type expansion, or undercut type anchors.
         2) Acceptable Products and Manufacturers – Normalweight and Sand-Lightweight Concrete Not on Corrugated Steel Deck:
            a) Hilti, Inc.; Kwik Bolt TZ (ESR-1917).
            b) Hilti, Inc.; HDA Undercut Anchor (ESR-1546).
            c) Hilti, Inc.; HSL-3 Heavy Duty Sleeve Anchor (ESR-1545).
            d) Simpson Strong-Tie Co., Inc.; Strong-Bolt Wedge Anchor (ESR-1771).

e) Simpson Strong-Tie Co., Inc.; Strong-Bolt 2 Wedge Anchor (ESR-3037).
f) USP Structural Connectors; DUC Undercut Anchor (ESR-1970).
g) Dewalt; Power Stud+ SD1 Expansion Anchor (ESR-2818).
h) Dewalt; Power Stud+ SD2 Anchor (ESR-2502).
i) Dewalt; Atomic+ Undercut Anchor (ESR-3067).
j) Dewalt; Power-Bolt+ Sleeve Anchor (ESR-3260)

3) Acceptable Products and Manufacturers – Normalweight and Sand-Lightweight Concrete on Corrugated Steel Deck:
a) Hilti, Inc.; Kwik Bolt TZ (ESR-1917).
b) Simpson Strong-Tie Co., Inc.; Strong-Bolt Wedge-Anchor (ESR-1771).
c) Dewalt; Power Stud+ SD1 Expansion Anchor (ESR-2818).
d) Dewalt; Power Stud+ SD2 Anchor (ESR-2502).

b. Screw and Insert Anchors in Concrete:
1) Acceptable Products and Manufacturers:
a) Hilti, Inc.; KWIK HUS-EZ Anchor (ESR-3027).
b) Simpson Strong-Tie Co., Inc.; Titen HD (ESR-2713).
c) Dewalt; Snake+ Anchor (ESR-2272).
d) Dewalt; Screw-Bolt+ (ESR-3889).

c. Adhesive Anchoring Systems in Concrete:
1) Chemical anchoring of anchors, rods, or reinforcing steel is not allowed for fire-rated assemblies, unless specified provided for in the drawings.
2) Consult with the manufacturer for the minimum temperature of the concrete substrate allowed.
3) Only personnel trained to install adhesive anchors and certified in accordance with the ACI/CRSI Adhesive Anchor Installer Certification Program shall install adhesive anchors, including reinforcing steel.
4) All anchors installed horizontally or upwardly inclined require continuous inspection.
5) All adhesive anchors shall be installed in concrete having a minimum age of 21 days at the time of anchor installation.
6) Acceptable Products and Manufacturers:
a) Hilti, Inc.; HIT-HY 200 (ESR-3187).
b) Hilti, Inc.: HIT-RE 500 V3 (ESR-3814)
c) ITW Red Head; EPCON G5 (ESR-1137).
d) ITW Red Head; EPCON S7 (ESR-2308).
e) Dewalt; PE 1000+ (ESR-2583).
f) Dewalt; Pure110+ (ESR-3298).
g) Dewalt; AC200+ (ESR-4027).
h) Simpson Strong-Tie; SET-XP Adhesive (ESR-2508).
i) Simpson Strong-Tie; SET-3G Adhesive (ESR-4057).
j) Simpson Strong-Tie; AT-XP (IAPMO ER-263).
7) These products may not be used in concrete cast over corrugated deck.
8) Threaded Rods Chemically Anchored in Concrete:
a) Type: Threaded rods installed in holes using a chemical anchoring process shall have a 45º chiseled end on the embedded end.
b) Interior Application: Meet the requirements of ASTM A 307, A 36 or A 193, grade B7.
c) Exterior Application: Meet the requirements of ASTM A 153 galvanized steel, or F 593, Group 1 or 2, condition CW stainless steel.
9) Steel Reinforcing Bars:
a) Reinforcing steel installed shall comply with ASTM A 615 or ASTM A706 unless noted otherwise in the structural drawings. The embedded portions of reinforcing bars must be straight, and free of mill

scale, rust, mud, oil and other coatings that may impair the bond with the adhesive.

b) Reinforcing bars must not be bent after installation except as permitted in the structural drawings. Heating of reinforcing bars to facilitate field bending is not permitted.

B. Bonding Compound: Polyvinyl acetate or acrylic base, for use in cosmetic and/or nonstructural repairs.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Acrylic or Styrene Butadiene:
         1) Dayton-Superior Corporation; Acrylic Bonding Agent J40.
         2) The Euclid Chemical Company; SBR Latex, Akkro-7T.
         3) GCP Applied Technologies; Daraweld C.
         4) BASF Corporation: MasterEmaco A 400
         5) Sika Corporation; SikaLatex.
         6) W.R. Meadows, Inc; Acry-Lok.
         7) US Mix Co.; US Spec Acrylcoat.
         8) SpecChem, LLC; Strong Bond Acrylic Bonder.
      b. Polyvinyl Acetate (Interior Use Only):
         1) The Euclid Chemical Company; Tammsweld.
         2) L&M Construction Chemicals; Primer One.
         3) Dayton-Superior Corporation; PVA Bonding Agent J41.
         4) SpecChem, LLC; SpecWeld.
         5) W.R. Meadows, Inc; Intralok.

C. Epoxy Products: Two-component material suitable for use on dry or damp surface, complying with ASTM C 881.
   1. Products for Crack Repair:
      a. Sika Corporation; Sikadur 35 Hi Mod LV – injection type.
      b. Sika Corporation; Sikadur 52 – injection type.
      c. Sika Corporation; Sikadur 55 SLV – gravity feed.
      d. The Euclid Chemical Company; Dural Injection Gel.
      e. Dayton-Superior Corporation, Inc; Sure-Inject (J56 or J56SLV).
      f. BASF Corporation; MasterInject 1000.
      g. Simpson Strong-Tie Co., Inc.; ETI-LV or ETI-GV – injection type.
      h. Unitex; Pro-Poxy 100 or Pro-Poxy 50.
      i. Adhesives Technology; Crackbond LR 321 or Crackbond LR 321 LPL.
      j. W.R. Meadows, Inc; Rezi-Weld LV.
      k. SpecChem LLC; SpecPoxy 1000.
   2. Products for Epoxy Mortar Patches:
      a. Sika Corporation; Sikadur Lo-Mod LV.
      b. Dayton-Superior Corporation; Sure Patch.
      c. BASF Corporation; MasterInject 1500.
      d. Unitex; Pro-Poxy 2500.
      e. W.R. Meadows, Inc; Rezi-Weld 1000.
      f. SpecChem, LLC; SpecPoxy Binder.
   3. Products for Epoxying Steel Plates to Concrete: Conform to ASTM C 881-13, Type IV, Grade 3, Class A, B, & C except gel times.
      a. Sika Corporation; Sikadur 31 Hi-Mod Gel.
      b. Dayton-Superior Corporation, Inc; Sure Anchor J50 or Sure Bond J58
      c. BASF Corporation; MasterEmaco ADH 1420.
      d. Unitex; Pro-Poxy 300.
      e. The Euclid Chemical Company; Duralcrete Gel.
      f. SpecChem, LLC; SpecPoxy 3000.

D. Reglets: Where resilient or elastomeric sheet flashing or bituminous membrane is terminated in reglets, provide reglets of not less than 26 gauge galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

E. Contraction and Construction Joint-Filler Material for Slabs-on-Grade: Provide a two-component semi-rigid, 100% solids epoxy having a minimum Shore A Hardness of 80 when tested in accordance with ASTM D 2240. Subject to compliance with requirements, provide one of the following:
1. The Euclid Chemical Company; Euco 700.
2. Dayton-Superior Corporation, Inc.; Sure Fil J52
3. BASF Corporation; MasterSeal CR 190.
4. Metzger/McGuire Co.; MM-80.
5. W.R. Meadows, Inc; Rezi-Weld Flex.
6. SpecChem, LLC; SpecPoxy CJ.

F. Bondbreaker for Construction Joints in Slabs-on-Grade: A dissipating bondbreaking compound containing no silicones, resins, or waxes, and that conforms to ASTM C 309. Subject to compliance with requirements, acceptable manufacturers include the following:
1. Dayton-Superior Corporation, Inc.; Sure-Lift J6WB.
2. SpecChem, LLC; SpecTilt 100.

G. Joint-Filler Strips for Isolation Joints in Slabs-on-Grade: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

H. Rigid-Cellular-Polystyrene Boards use as Fill under Topping Slabs or Slabs-on-Grade: Provide rigid, expanded (EPS) or extruded (XPS) cellular polystyrene boards that conform to ASTM D 6817 or ASTM C 578 with a minimum density of 15 kilograms per cubic meter; a flame spread index of not more than 75 and a smoke-develop index of not more than 450 where tested for use in accordance with ASTM E 84 or UL 723. Subject to compliance with requirements, acceptable manufacturers include the following:
1. Dow Chemical Company; STYROFOAM Brand.
2. Therma Foam; Foam-Control EPS Geofoam.
3. Carpenter Co.; EPS Envirogreen Geofoam.
4. Insulfoam; Insulfoam GF (EPS Geofoam).

2.8 REPAIR MATERIALS

A. Self-Leveling Mortars, Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound. Follow manufacturer's instruction regarding the use of a bonding agent.
1. Products: Unless specified otherwise, provide one of the following:
   a. BASF Corporation; MasterTop 110 SL.
   b. The Euclid Chemical Company; Flo-Top,Super Flo-Top.
   c. Dayton-Superior Corporation, Inc; Levelayer.
   d. US Mix Co.; US Spec Self-Leveling Underlayment.
   e. The Euclid Chemical Company; Level Magic Lightweight.
   f. SpecChem, LLC; SpecFlow.

B. Polymer Patching Mortar: Polymer and microsilica modified cementitious-based compounds.
1. Products:
   a. Horizontal Application:
      1) The Euclid Chemical Company; Thin Top Supreme, Concrete Top Supreme.
      2) Sika Corporation; Sikatop 121 Plus or Sikatop 122 Plus.

3) BASF Corporation; MasterEmaco T 310CI.
4) BASF Corporation; MasterEmaco N424 or N423 RS.
5) US Mix Co.; US Spec H2 or NuTop.
6) The Euclid Chemical Company; Speed Crete PM.
7) SpecChem, LLC; RepCon H.
8) Dayton-Superior Corporation; Thin Resurfacer or Special Patch.

b. Upwardly Inclined Application:
1) The Euclid Chemical Company; Verticoat or Verticoat Supreme.
2) Sika Corporation; Sikatop 123 Plus.
3) BASF Corporation; MasterEmaco N 350CI.
4) BASF Corporation; MasterEmaco N423 RS.
5) US Mix Co.; US Spec V/O Patch CI.
6) The Euclid Chemical Company; Speed Crete PM.
7) SpecChem, LLC; RepCon V/O.
8) Dayton-Superior Corporation; Civil/Structural VO.

C. High Strength Flowing Repair Mortar: For forming and pouring structural members, or large horizontal repairs, provide flowable one-part, high strength microsilica polymer modified repair mortar with 3/8" aggregate. The product shall achieve 9,000 PSI at 28-days at a nine inch slump.
1. Products:
a. BASF Corporation; MasterEmaco T 1060.
b. US Mix Co.; US Spec STR Mortar.
c. The Euclid Chemical Company; Eucocrete.
d. The Euclid Chemical Company; Tamms Form and Pour.
e. SpecChem, LLC; RepCon 928.
f. Dayton-Superior Corporation; Civil/Structural FPX.

D. Anti-Corrosive Epoxy/Cementitious Adhesive: Water-based epoxy/cementitious compound for adhesion and corrosion protection of reinforcing members (20 hour maximum open time).
1. Products:
a. The Euclid Chemical Company; Duralprep A.C.
b. Sika Corporation; Sika Armatec 110 Epocem.
c. BASF Corporation: MasterEmaco P 124.
d. Dayton-Superior Corporation; Perma Prime 3C.

2.9 PROPORTIONING AND DESIGN OF CONCRETE MIXTURES

A. The Contractor shall submit design concrete mixtures for each class of concrete indicated on the structural drawings and in the Specifications for approval by the Engineer and Owner's Testing Laboratory at least 15 working days prior to the start of construction. If required, the Contractor shall engage the services of an independent Testing Laboratory to assist in preparing the design mixtures. The Contractor shall not begin work with a particular mixture until that design mixture has been approved.

B. The Contractor, acting in conjunction with his Concrete Supplier and his Testing Laboratory, shall submit in writing, with his design mixtures, the method used to select mixture proportions. Either of the following methods, as outlined in ACI 301, may be used:
1. Field Experience Method.
2. Laboratory Trial Mixture Method.

C. Required types of concrete and compressive strengths shall be as indicated on the Structural Drawings.

D. All design mixtures shall state the following information:
   1. Design mixture number or code designation by which the Contractor shall order the concrete from the Supplier.
   2. Identify design mixture usage (i.e., columns, shear walls, footings, slab-on-grade, etc.).
   3. Wet and dry unit weights.
   4. Compressive strength and associated age (28-day, 56-day, etc.).
   5. Aggregate type, source, size, gradation, fineness modulus.
   6. Cement type and brand.
   7. Fly ash or other pozzolan type and brand (if any).
   8. Admixtures including air entrainment, water reducers, high-range water reducers, accelerators, and retarders.
   9. Design slump or slump/flow.
   10. Proportions of each material used.
   11. Water/cementitious ratio and maximum allowable water content.
   12. Method by which the concrete is intended to be placed (bucket, chute, or pump).
   13. Required average strength qualification calculations per ACI 301 4.2.3.3a and 4.2.3.3b. Submit separate qualification calculations for each production facility that will supply concrete to the project.
   14. Documentation of Average Strength (Trial Mixture Data or Field Test Data) per ACI 301: When field test data is used to qualify average strength, submit separate documentation for each production facility that will supply concrete to the project.
   15. Field test data submitted for qualification of average strength under ACI 301 shall include copies of the Concrete Testing Agency's reports from which the data was compiled.

E. Low Alkali Concrete: For concrete identified on the drawings as Exposure Classes C1 and C2, the total alkali contribution from cementitious materials in the concrete mix shall not exceed 4.0 pounds per cubic yard of concrete unless the aggregate used is certified to contain no deleterious materials that react with alkalis in the concrete mix as defined in ASTM C 33. This requirement may be met by the use of low-alkali cement.

F. Supplementary Cementitious Materials: Fly ash and/or ground granulated blast-furnace slag replacement of Portland cement shall be within percentage replacement levels listed on the drawings unless noted otherwise. Every effort should be made to reduce the amount of cement to the minimum practical amount, and still achieve performance requirements contained in the Contract Documents.
   1. Cement replacement shall not exceed a percentage level that has been shown by experience on other projects to exhibit satisfactory performance using materials from identical sources as proposed for this project. As an alternate, trial concrete batches can be performed to identify design mixtures that maximize cement replacement while meeting strength requirements per ACI 318 Section 5.3 and finishability criteria.
   2. The use of fly ash or slag in architecturally exposed structural concrete shall be coordinated with the Architect, Engineer, and Contractor.
   3. Overall replacement percentages with combined fly ash and slag shall not exceed the maximum identified with slag or be less than the minimum identified with fly ash for each type of element. In addition, the replacement percentage of fly ash within the combined mixture shall not exceed the maximum identified with fly ash alone.
   4. Replacement percentages exceeding the maximum may be permitted at the discretion of the Architect, Engineer of Record, and Contractor.
   5. For concrete identified on the drawings as being subject to Exposure Class F3, the maximum amount of supplementary cementitious materials shall not exceed the limits noted in Table 4.2.2.7.b.2 “Maximum cementitious materials requirements for concrete exposed to deicing chemicals” of ACI 301.

6. Except for Mass Concrete, the Contractor may submit for approval a revised design mixture with lower supplementary cementitious material percentages than herein specified should finishability or other issues arise due to changing weather conditions.

G. Aggregate: Comply with the following special requirements:
1. For exposed concrete, provide aggregates from a single source.
2. For exposed surfaces subject to Exposure Class C1 or C2, do not use aggregates containing spalling-causing deleterious substances.
3. For slabs and other designated concrete, combined aggregate gradation shall be 8% - 18% for large top size aggregates (1 1/2 inches) or 8% - 22% for smaller top size aggregates (1 inch or 3/4 inch) retained on each sieve below the top size and above the No. 100. Deviations from this gradation may be allowed upon the approval of the Engineer subject to the following limitations:
   a. The percent retained on two adjacent sieves shall be not less than 5%.
   b. The percent retained on three adjacent sieves shall be not less than 8%.
   c. If the percent retained on two adjacent sieves is less than 8%, the total percent retained on either of those sieves and the adjacent outside sieve shall be not less than 13%.

H. Admixtures:
1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Owner's Testing Laboratory and shall be used for the purpose intended by the manufacturer to produce concrete to meet the specified requirements.
2. Quantities of admixtures to be used shall be in strict accordance with the manufacturer's instructions.
3. Air Content Requirements: For concrete subject to Exposure Class F1, F2 or F3 as noted on the drawings, use air-entrainment admixtures to provide concrete such that the air content at the point of placement shall conform to the requirements of ACI 301 Table 4.2.2.7.b "For Exposure Category F: Freezing and thawing exposures" within plus or minus 1.5%. Required air content levels may be reduced by 1.0 percent for concrete strengths above 5,000 PSI.
   a. Interior steel troweled surfaces shall not have more than 3% total air content.
   b. Surfaces scheduled to receive hardeners shall not have more than 3% total air content.
   c. Air-entraining admixtures are not permitted in industrial slabs.

I. Adjustments of Concrete Mixtures: Design mixture adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Such adjustments shall be provided at no additional cost to the Owner. Any adjustments in approved design mixtures including changes in admixtures shall be submitted in writing to the Engineer and Owner's Testing Laboratory for approval prior to field use.

J. Chloride Ion Content:
1. Unless noted otherwise, the maximum water soluble chloride ion concentration in hardened concrete measured at ages from 28 to 42 days contributed from all ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits specified in ACI 318-14 Table 19.3.2.1 "Requirements for concrete by exposure class" depending on to which Corrosion Exposure Class (C0, C1 or C2) the concrete is subject as noted on the drawings. Water-soluble chloride ion tests shall conform to ASTM C 1218. One test shall be run for each class of concrete before the design mixture submittal and each time a change is made to the design mixture (such as change in aggregate type or source).
2. The chloride ion content in all concrete used for prestressed or post-tensioned concrete shall not exceed 0.06 percent by weight of cement.

3. The Concrete Supplier shall certify that the chloride ion content in all concrete design mixtures used on the project does not exceed the limits stated above.

2.10 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94 and the Structural Testing and Inspections section of the specifications.

2.11 SOURCE QUALITY CONTROL

A. Source Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for inspection requirements associated with cast-in-place concrete.

PART 3 - EXECUTION

3.1 SLUMP LIMIT

A. The slump, as measured in the field where concrete cylinders are taken, shall be within plus or minus 1-1/2 inches of the design slump noted in the approved Design Mixture submittal. Self-Consolidating Concrete shall have a slump/flow of plus or minus two inches of the design slump/flow noted on the approved Design Mixture submittal. Water may be added to the concrete in the field only to the extent that the prescribed water/cementitious ratio noted in the approved Design Mixture submittal is not exceeded. The responsibility for adding water to trucks at the job site shall rest only with the Contractor’s designated representative. The Contractor is responsible that all concrete placed in the field is in conformance with the Contract Documents.

3.2 VAPOR RETARDER INSTALLATION

A. Install and repair damaged vapor retarder in accordance with ASTM E 1643 and manufacturer’s instructions.

B. Lap all seams per manufacturer’s instruction (6” minimum lap) and seal all joints in the field with the specified pressure sensitive tape. Heat-welded joints done in a shop prior to delivery is an acceptable method to minimize the number of field joints.

C. Seal all pipe penetrations through the vapor retarder with a boot made from the vapor retarder material and tape or mastic.

3.3 JOINTS IN CONCRETE

A. Construction Joints: Locate and install construction joints as indicated on the drawings or if not shown on drawings, located so as not to impair strength and appearance of the structure, as acceptable to Architect/Engineer.
   1. Keyways: Provide keyways with a depth of one tenth of the member thickness (1 1/2" minimum or as shown on the drawings) in construction joints only where shown on the drawings.
   2. Joint Construction: Place construction joints in the center one third of suspended spans and grade beams and as shown on the drawings for slabs-on-grade and walls unless

shown otherwise. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise shown on the drawings. Dowels that cross construction joints shall be supported during concreting operations so as to remain parallel with the slab or wall surface and at right angles to the joint. Submit all construction joint locations as a shop drawing submittal.

Waterstops: Provide waterstops in construction joints as indicated on the Architectural and Structural Drawings. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.

3. Isolation Joints in Slabs-on-Grade: Construct isolation joints (without dowels) in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces only where specifically detailed on the drawings. Install joint-filler strips at joints where indicated. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated on the drawings. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together. Provide construction joints with dowels at all locations unless isolation joints are detailed.

B. Contraction Joints in Slabs-on-Grade: Install contraction joints at locations and spacings as indicated on the drawings or if not shown on drawings, located so as not to impair strength and appearance of the structure, as acceptable to Architect/Engineer. Maximum joint spacing shall be per the drawings and be perpendicular to the slab surface. Use one of the two following methods (sawed or formed) to create the joints. Do not use the formed joint in areas subject to vehicular traffic or in industrial slabs.

1. Sawed Joints:
   a. Primary Method: Early-Entry, dry-cut method, using Soff-Cut saws. Finisher must have documented successful experience in the use of this method prior to this project. Install cuts within one to four hours, depending on air temperature, after final finish as soon as the concrete surface is firm enough to not be torn or damaged by the blade at each saw cut location. Use 1/8 inch thick blade, cutting to a depth of one quarter of the slab thickness but not less than one inch. Cut to a depth of one third of the slab thickness for slabs reinforced with steel fibers or synthetic fibers.
   b. Optional Method (where Soff-Cut System method equipment is not available, subject to limitations): This method may not be used when there is no dowel passing through the contraction joint. Use a conventional saw to cut joints within four to 12 hours after finishing as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use 1/8 inch thick blade, cutting to a depth of one quarter of the slab thickness but not less than one inch. Cut to a depth of one third of the slab thickness for slabs reinforced with steel fibers.
2. Formed Joints: Form contraction joints by inserting premolded plastic hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. The depth is to be one quarter of the slab thickness, but not less than one inch. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
3. Joint Filler: Provide in both contraction and saw-cut construction joints when specified.
   a. Remove dirt and debris from the joint by vacuuming immediately prior to filling joint. Clean the joint of curing compounds and sealers.
   b. Filler material shall be applied to the joints when the building is under permanent temperature control, but no less than 90 days after slab construction.
   c. Follow the manufacturer's recommended procedure for installing filler material. The joint filler must be flush with the adjacent concrete. A concave profile on the top of the joint filler is unacceptable and will be grounds for removal and replacement.

4. The Contractor shall protect the joints from damage caused by wheeled traffic or other sources during construction until a joint-filler material (if specified) has been installed.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto unless directed otherwise by these specifications. Install reglets to receive top edge of foundation sheet waterproofing where specified by the Architect, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles and other conditions.

B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

C. Do not install sleeves in any concrete member except where shown on the structural drawings or approved by the Architect and Engineer.

D. Securely fasten embedded plates, angles, anchor rods and other items to be built into the concrete to the formwork or hold in place with templates. Insertion of these items into concrete after concrete placement is prohibited.

3.5 CONCRETE PLACEMENT

A. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. Concrete Batch Trip Tickets: The Contractor shall collect and retain concrete batch trip tickets. Compressive strength, slump, air content, and temperature tests shall be identified by reference to a particular trip ticket. Tickets shall contain the information specified in ASTM C 94. Each ticket shall also show the amount of water that may be added in the field for the entire batch that will not exceed the specified water cement ratio for the design mixture. The Contractor and Testing Laboratory shall immediately notify the Architect/Engineer and each other of tickets not meeting the criteria specified.

C. Causes for Rejection of Concrete: The Contractor shall reject concrete delivered to the site for any of the following reasons:
   1. Wrong class of concrete (incorrect design mixture number).
   2. Environmental condition limits shall be as follows unless appropriate provisions in concrete practices have been made for cold or hot weather:
      a. Cold Weather: Air temperature must be 40°F and rising or the average daily temperature cannot have been lower than 40°F for three consecutive days unless the temperature rose about 50°F for at least one-half of any of those 24 hour periods.
      b. Hot Weather: Environmental conditions must be such that cause an evaporation rate from the concrete surface of 0.2 pounds per square foot per hour or less as determined by the figure “NRMCA Nomograph for Estimating Evaporation Rate on the Basis of Menzel Formula” in Appendix A of ACI 305.1.

c. Concrete may be placed at other environmental condition ranges only with the approval of the job inspector for the Testing Laboratory or other duly appointed representative.

3. Concrete with temperatures exceeding 95°F.
4. Air contents outside the limits specified in the design mixtures.
5. Slumps outside the limits specified.
6. Water added to the mix that exceeds the maximum allowed water-to-cementitious material ratio.
7. Excessive Age: Concrete shall be discharged within 90 minutes of plant departure or before it begins to set if sooner than 90 minutes and it shall be discharged before the drum has revolved 300 revolutions, unless approved by the Testing Laboratory job inspector or other duly appointed representative.

D. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

E. Comply with ACI 301 and as herein specified:
1. Concrete Temperature: The maximum acceptable concrete temperature at the truck discharge point shall be 95°F.
2. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation. Spread concrete using short-handled, square-ended shovels, or come-alongs.
3. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
4. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use internal vibrators of the largest size and power that can properly be used in the work.
5. Do not vibrate Self-Consolidating Concrete.
6. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to penetrate rapidly placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
7. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as concrete for slabs. Do not place concrete over columns and walls until concrete in columns and walls is no longer plastic and has been in place at least one hour.
8. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.
9. Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedges, bull floats, or darbies to smooth surface free of humps or hollows before excess moisture or bleedwater appears on the surface. Do not disturb slab surfaces prior to beginning finishing operations.
10. Maintain reinforcing in proper position during concrete placement operations.
11. Protect adjacent finish materials against damage and spatter during concrete placement.

12. Placing Concrete by Pump: If concrete is placed by using a pump, the grout used for pump priming must not become a part of the completed structure unless an engineered grout design mix and grout location are approved in advance by the Engineer.

3.6 FINISH OF FORMED SURFACES

A. General: Formed surfaces shall have the finishes as described below and as shown on the drawings after formwork is removed and repairs made.

B. Matching Mockup Finish: In all areas where a special finish is required or a mock-up is required below, Contractor shall prepare a 100 square foot mock-up to match the required finish. The mock-up should match the finish on a sample panel furnished to the Contractor. If a sample is not furnished, provide finish to match SF2.0 or any other finish specified for the project. Protect mock-up from damage for the duration of project. Approval of mock-up by Architect is required before proceeding with application of finish in project.

C. Classifications and Finish Requirements:
   1. Surface Finish 1.0 (SF-1.0):
      a. No formwork facing material is specified.
      b. Patch voids larger than 1-1/2 inch wide or 1/2 inch deep.
      c. Remove projections larger than 1.0 inch.
      d. Provide surface tolerance Class D as specified in ACI 117.
      e. Tie holes need not be patched.
   2. Surface Finish 2.0 (SF-2.0):
      a. Provide specified formwork-facing material.
      b. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
      c. Patch tie holes.
      d. Remove projections larger than 1/4 inch.
      e. Provide surface tolerance Class B as specified in ACI 117.
      f. Provide mock-up of concrete surface appearance.

D. Standard Finish: Provide SF-1.0 on all concrete surfaces not exposed to view in the final condition unless otherwise specified.

E. Exposed Finishes: Provide SF-2.0 on all concrete surfaces exposed to view in final condition unless otherwise specified.

F. Rubbed Finishes: Remove forms as early as permitted by these specifications and perform any necessary repairs and patches. Unless otherwise specified, provide one of following finishes where rubbed concrete finish is specified or scheduled:
   1. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled or specified concrete surfaces where indicated, not later than one day after form removal. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
   2. Grout Cleaned Finish: Provide grout cleaned finish to scheduled or specified concrete surfaces that have received smooth-form finish treatment.
      a. Combine one part portland cement to 1-1/2 parts sand meeting the requirements of ASTM C 144 and ASTM C 404 by volume, and 50:50 mixture of acrylic or styrene butadiene based bonding admixture and water to consistency of thick paint. Proprietary additives may be used at Contractor's option. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

b. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

G. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 MONOLITHIC SLAB FINISHES

A. Place, consolidate, strike off, and level concrete, eliminating high spots and low spots, before proceeding with any other finish operation. Do not add water to the surface of the concrete during finishing operation.

B. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerance specified below. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.

C. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using a hand float, a bladed power float equipped with float shoes, or a powered disk float, when the bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit the operation. Check and level surface plane to a tolerance as specified below. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint or other thin film finish coating system. After floating, begin first trowel finish operation by hand or power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a level surface to a tolerance as specified below. Grind smooth surface defects that would telegraph through applied floor covering system.

E. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply initial trowel finish as specified above, then immediately follow with slightly scarifying surface by fine brooming.

F. Slip-Resistive Broom Finish: Apply slip-resistive broom finish to garage floors and ramps less than 6% slope, exterior concrete platforms, steps, and ramps and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application. For concrete containing fibers, broom once only in one direction..

G. Penetrating Sealer Finish: Apply a chloride-and-water-repelling-penetrating-sealer finish to surfaces as described below and where indicated on the drawings. Apply liquid penetrating sealer after complete curing and drying of the concrete surface. Apply proprietary sealers in strict accordance with manufacturer's printed instructions. The Contractor shall verify the compatibility

of the sealer product with the paint used to stripe parking decks and coordinate the sequencing of the sealing and striping operations. Apply to the following surfaces:
1. Sloping and horizontal surfaces of parking garages.
2. Top surfaces of exposed exterior balconies.

H. Slip-Resistive Aggregate Finish: Apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps, and elsewhere as indicated on the Architect's or Structural Drawings.
1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 pounds of dampened slip-resistive aggregate per 100 square feet of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
2. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose slip-resistive aggregate.
3. Cast a trial slab approximately 20 feet by 20 feet to determine actual application rate, color, and finish as acceptable to Architect/Engineer.
4. Immediately following first floating operation using wood floats, uniformly distribute approximately two thirds of required weight of dry shake material over concrete surface, and embed by means of power floating using float shoes or pan floats. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material at right angles to first application, and embed by power floating.
5. After completion of broadcasting and floating, apply trowel finish as herein specified. Cure slab surface with curing compound recommended by dry shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.8 CONCRETE FINISH MEASUREMENT AND TOLERANCES

A. Testing Procedure: ASTM E 1155.

B. Tolerance on Floor Elevations: Construction tolerance on absolute floor elevation from the specified elevation as shown on the drawings shall be as specified below, taken from ACI 117:
1. Slab-on-Grade Construction: ±3/4".
2. Top Surfaces of Formed Slabs Measured Prior to Removal of Supporting Shores: ±3/4".
3. Top Surfaces of All Other Slabs: ±3/4".

C. Random Traffic Floor Finish Tolerances:
1. Specified overall values for flatness (SOF_F) and levelness (SOF_L) shall conform to the values listed below for the floor surface classification noted for each slab category noted.
   a. Conventional:
      1) SOF_F: 20.
      2) SOF_L: 15.
   b. Moderately Flat:
      1) SOF_F: 25.
      2) SOF_L: 20.
   c. Flat:
      1) SOF_F: 35.
      2) SOF_L: 25.
   d. Very Flat:
      1) SOF_F: 45.
      2) SOF_L: 35.
   e. Super Flat:
      1) SOF_F: 60.
      2) SOF_L: 40.

2. Minimum local values for flatness (MLF_F) and levelness (MLF_L) shall equal 3/5 of the SOF_F and SOF_L values, respectively, unless noted otherwise. The MLF_F and MLF_L values shall apply to the minimum areas bounded by the column lines and half-column lines, or the minimum areas bounded by the construction and contraction joints, whichever are the smaller areas.
3. The SOF_L and MFL_L tolerance values shall apply only to level slabs-on-ground or to level, uncambered suspended slabs that are shored such that it cannot deflect from the time the floor is placed to the time it is measured.
4. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10 feet at any point.

D. Construction Requirements to Achieve Specified Floor Finish Tolerances:
1. Forms shall be properly leveled, in good condition, and securely anchored including special attention to ends and transitions.
2. Bearing surfaces for straightedges such as form edges or previously poured slabs shall be kept clean of laitance, sand, gravel, or other foreign elements.
3. Screeds shall be maintained in good condition with true round rolling wheels and level cutting edges. The use of optical sighting equipment such as lasers is recommended for checking levelness and straightness. The Contractor shall promptly adjust or replace equipment when test results indicate substandard work.
4. Highway straightedges are recommended for use in lieu of bullfloats for all slab placement and finishing operations. If mineral, non-oxidizing metallic, or metallic floor hardeners are used, the slab shall be wood bullfloated immediately after the straightedge.

E. Contractor Responsibility for Concrete Floor Finish Requirements: Floor finish requirements shown below (flatness and levelness tolerances) are minimum requirements that apply unless stricter requirements are contained in instructions for installation of applied floor products in which case the Contractor is responsible for attaining the values prescribed by the manufacturer of such products.

F. Concrete Floor Finish Tolerance for Slab-on-Grade Construction:
1. Concrete Placement: Concrete shall be placed and screeded to predetermined marks set to elevations prescribed on the drawings.
2. Finish Tolerances of Random Traffic Floor Surfaces:
   a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures: Conventional.
   b. Carpeted Areas: Moderately Flat.
   c. Exposed Slabs in Public Spaces, Slabs to Receive Thin-Set Flooring: Flat.

G. Concrete Floor Finish Tolerance for Shored, Cast-in-Place Suspended Slab Construction:
1. Finish Tolerances of Random Traffic Floor Surfaces:
   a. Slabs in Nonpublic Areas, Mechanical Rooms, Surfaces to Received Raised Computer Flooring, Surfaces to Have Thick-Set Tile or a Topping, and Parking Structures: Conventional.
   b. Carpeted Areas: Moderately Flat.
   c. Exposed Slabs in Public Spaces, Slabs to Receive Thin-Set Flooring: Flat.
2. Extra Concrete: The contractor shall include in his bid any additional concrete required to achieve the specified slab surface finish tolerance.

H. Concrete Floor Finish Tolerance – Unshored Steel Deck on Shored or Unshored Steel Beam or Steel Joist Floor Construction:
1. Concrete Placement: Concrete over steel deck shall be placed and screeded level and flat to the tolerance specified below, maintaining at least the minimum slab thickness at all

locations as specified on the drawings. The Contractor shall increase the slab thickness as required to compensate for steel deck deflection, and in unshored beam construction, residual beam camber and beam deflection in order to achieve a level and flat floor within specified tolerances.

2. Finish Tolerance of Random Traffic Floor Surfaces:
   a. Slabs in Nonpublic Areas, Mechanical Rooms, Surfaces to Received Raised Computer Flooring, Surfaces to Have Thick-Set Tile or a Topping, and Parking Structures: Conventional.
   b. Carpeted Areas: Moderately Flat.
   c. Exposed slabs in public spaces, slabs to receive thin-set flooring: Flat.
   d. Eighty percent (80%) of the final floor surface shall fall within an envelope of 0.75" centered about the mean elevation of all the readings. The mean elevation of all readings shall not deviate from the specified design grade by more than ± 0.375".
3. Extra Concrete: The Contractor shall include in his bid any additional concrete required to achieve the specified slab surface finish tolerance and to compensate for steel deck deflection, beam camber and beam deflection.

I. Remedial Measures for Slab Finish Construction Not Meeting Specified Tolerances:
   1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:
      a. The composite overall values of F_F or F_L of the entire floor installation measure less than specified values.
      b. Any individual test section measures less than the specified absolute minimum F_F or F_L value.
   2. Modification of Existing Surface:
      a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately undertake the approved repair method.
      b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair, and time to affect the repair.
      c. Repair method(s), at the sole discretion of the Architect/Engineer or Owner's Representative, may include grinding (floor stoning), planing, retopping with self-leveling underlayment compound or repair topping, or any combination of the above.
      d. The Architect/Engineer or Owner's Representative maintains the right to require a test repair section using the approved method of repair for review and approval to demonstrate a satisfactory end product. If, in the opinion of the Architect/Engineer or Owner's Representative, the repair is not satisfactory an alternate method of repair shall be submitted or the defective area shall be replaced.
      e. The judgment of the Architect/Engineer or Owner's Representative on the appropriateness of a repair method and its ability to achieve the desired end product shall be final.
      f. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.
   3. Removal and Replacement:
      a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately commence to remove and replace the defective work.
      b. Replacement section boundaries shall be made to coincide with the test section boundaries as previously defined.

c. Sections requiring replacement shall be removed by sawcutting along the section boundary lines to provide a neat clean joint between new replacement floor and existing floor.
d. The new section shall be reinforced the same as the removed section and doweled into the existing floor as required by the Engineer. No existing removed reinforcing steel may be used. All reinforcing steel shall be new steel.
e. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
f. The judgment of the Architect/Engineer or Owner's Representative on the need for replacement shall be final.
g. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3.9 CONCRETE CURING AND PROTECTION

A. General:
1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete. Limit moisture loss to a maximum of 0.05 pounds per square foot per hour for concrete containing silica fume and 0.2 pounds per square foot per hour for all other concrete before and during finishing operations. If using an evaporation retarder, apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be seven days for all concrete except high early strength concrete that shall be cured for three days minimum.
3. Alternatively, curing times may be reduced if either of the following provisions is complied with:
   a. If tests are made of cylinders kept adjacent to the structure and cured by the same methods, curing measures may be terminated when the average compressive strength has reached 70% of the specified compressive strength.
   b. If the temperature of the concrete is maintained at a minimum of 50°F for the same length of time required for laboratory cured cylinders of the same concrete to reach 85% of the specified compressive strength, then curing may be terminated thereafter.
4. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period.

B. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by one or a combination of the methods specified below, as applicable:
1. Basement Walls, Sides of Exterior Retaining Walls: Moist cure in forms or by one or a combination of Methods 1, 2, or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C 309, Type 1, class A or B for Method 3.

C. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by one or a combination of the methods specified below, as applicable. The Contractor shall choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.

1. Floors in Non-Public Spaces that are Left Exposed to View and Not Receiving Sealers or Hardeners, Floors Involved in Under-Floor Air Distribution Systems: Apply one coat of a high-solids, water-based, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, Class A or B in accordance with Method 3 as specified below.
2. Floors that are to Receive Subsequent Cementitious Toppings, Sealers, Hardeners, Ceramic Tile, Acrylic Terrazzo, Vinyl Composition Tile, Sheet Vinyl, Linoleum, Vinyl-Backed Carpet, Rubber, Athletic Flooring, Synthetic Turf, Wood, Epoxy Overlay or Adhesive, or Other Coating or Finishing Products: Cure using Methods 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C 309, Type 1, class A or B for Method 3.
3. All Other Surfaces: Cure using Methods 1, 2, or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C 309, Type 1, class A or B for Method 3.

D. Curing Methods:
1. Method 1 – Moisture Curing: Provide moisture curing by one of the following methods:
   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water, and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
2. Method 2 – Moisture-Retaining Cover Curing: Provide moisture-retaining cover curing as follows:
   a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Water may be added to concrete surface to prevent drying before the cover is installed, but the surface shall not be flooded with water if a non-absorptive cover is used.
3. Method 3 – Curing or Curing and Sealing Compound: Provide curing, liquid membrane-forming curing, or curing and sealing compound as follows:
   a. Apply specified compound to concrete slabs as soon as final finishing operations are complete (within two hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Do not allow to puddle. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. Apply second coat for sealing two to three hours after the first coat was applied.
   b. Do not use membrane-forming curing and sealing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glued-down carpet, vinyl composition tile, linoleum, sheet vinyl, rubber, athletic flooring, synthetic turf, or wood), paint, or other coatings and finish materials. Dissipating resin type cures are acceptable in these locations.

3.10 HOT WEATHER CONCRETING

A. Definition:
1. Conditions warranting hot weather concreting practices are defined as any combination of high air temperature, low relative humidity, and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise result in abnormal properties. If conditions

cause an evaporation rate of 0.2 pounds per square foot per hour or greater as calculated by the figure "NRMCA Nomograph for Estimating Evaporation Rate on the Basis of Menzel Formula" in Appendix A of ACI 305.1, then precautions shall be taken to prevent plastic shrinkage cracks from occurring.

B. Specification: Follow hot weather concreting practices specified below when required to limit the concrete temperature at the truck discharge point to the stated maximum acceptable temperature.

C. Records: Under hot weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature at truck discharge and general weather conditions.

D. Hot Weather Concreting Requirements: The following items, all or in part as required, shall be followed to limit the concrete temperature to the stated maximum acceptable temperature and to minimize the possibility of plastic shrinkage cracks from developing.
   1. Design the concrete mixtures specifically for hot weather conditions replacing some cement with fly ash or other pozzolan and using a water reducing retarding admixture (ASTM C 494 Type D).
   2. Use the largest size and amount of coarse aggregate compatible with the job.
   3. Use sunshades and/or windbreaks.
   4. Delay construction of indoor slabs-on-grade until the walls and roof are constructed.
   5. Cool and shade aggregate stockpiles.
   6. Use ice as part of the mixing water or cool the water with liquid nitrogen. Do not place concrete that contains unmelted ice.
   7. Limit the number of revolutions at mixing speed to 125 maximum.
   8. Reduce time between mixing and placing as much as possible.
   9. Do not add water to ready-mixed concrete at the job site unless it is part of the amount required initially for the specified water-cement ratio and the specified slump.
   10. Schedule concrete placement for early morning, late afternoon, or night.
   11. Have all forms, equipment, and workers ready to receive and handle concrete.
   12. Maintain one standby vibrator for every three vibrators used.
   13. Keep all equipment and material cool by spraying with water including exteriors of forms, reinforcing steel, subgrade, chutes, conveyors, pump lines, tremies, and buggies.
   14. Protect slab concrete at all stages against undue evaporation by applying a fog spray or mist above the surface or applying a monomolecular film. Where high temperatures and/or placing conditions dictate, use water-reducing retarding admixture (Type D) in lieu of the water-reducing admixture (Type A) as directed by the Owner's Testing Laboratory.
   15. Provide continuous curing, preferably with water, during the first 24 hours using wet burlap, cotton mats, continuous spray mist, or by applying a curing compound meeting ASTM C 1315. Continue curing for three days minimum.
   16. Cover reinforcing steel with water soaked burlap so that steel temperature will not exceed ambient air temperature immediately before placement of concrete.
   17. As soon as possible, loosen forms and run water down the inside. When forms are removed, provide a wet cover to newly exposed surfaces.

3.11 COLD WEATHER CONCRETING

A. Definition:
   1. Concrete shall not be placed when the outside air temperature is 40°F or less unless cold weather concreting practices are followed as specified below.
   2. Cold weather concreting practices should also be followed whenever the average daily air temperature is expected to be less than 40°F for more than three successive days. The average daily air temperature is the average of the highest and lowest temperature occurring during the period from midnight to midnight. The requirement for adhering to

these cold-weather concreting practices may be terminated when the air temperature is above 50º F for more than half of any 24 hour duration.

3. Cold-weather concreting practices invoked shall keep the temperature of the concrete immediately after placing within the following temperature ranges:
   a. 55º to 75º F for sections less than 12 inches in the least dimension.
   b. 50º to 70º F for sections 12 to 36 inches in the least dimension.
   c. 45º to 65º F for sections 36 to 72 inches in the least dimension.
   d. 40º to 60º F for sections greater than 72 inches in the least dimension.
4. Concrete Protection: Protect the concrete immediately after placing and during the defined protection period such that the concrete does not freeze nor fall below the temperature levels stated in the above paragraph. For concrete not loaded during construction, the protection period shall be for a minimum of three days if cold-weather conditions persist. The time may be reduced to a minimum of two days if Type III cement or an accelerating admixture is used or if an additional 100 pounds of cement per cubic yard is added to the concrete mix. Concrete fully loaded during construction shall be protected during cold weather conditions for whatever time is required to obtain the required strength as determined by nondestructive strength tests (Windsor probe, Swiss Hammer Test) on the in-place concrete. Protect concrete surfaces from freezing for the first 24 hours even if cold-weather conditions do not officially exist due to high volatility in ambient temperatures.
5. Protection Deficiency: If the temperature requirements during any portion of the protection period are not met but the concrete surface did not freeze, the protection period shall be extended until twice the deficiency expressed in degree-hours is made up. Deficiency degree-hours are defined as the average deficiency in temperature below the required value times the number of hours the deficiency persisted. Make-up degree hours are the average increase in temperature above the minimum value times the hours required to make up twice the deficiency degree-hours. Contact the Architect/Engineer if the concrete surface was allowed to freeze during the protection period.
6. Protection Removal: As the protection is being removed the decrease in temperature measured at the surface of the concrete in a 24 hour period shall not exceed the following:
   a. 50º F for sections less than 12 inches in the least dimension.
   b. 40º F for sections 12 to 36 inches in the least dimension.
   c. 30º F for sections 36 to 72 inches in the least dimension.
   d. 20º F for sections greater than 72 inches in the least dimension.
7. The maximum concrete temperature heated by artificial means at point of placement shall not exceed 90°F.

B. Records: Under cold weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature as placed and general weather conditions. The temperature record shall be taken no less than two times per 24 hour duration.

C. Cold Weather Concreting Requirements: The following items, all or in part as required, should be followed to assure acceptable concrete in cold weather conditions:
   1. Design the concrete mixture to obtain high early strength by using higher cement content, a high early strength cement (Type III), or a specified non-chloride accelerator (ASTM C 494 Type C or E).
   2. Protect the concrete during curing period using insulating blankets, insulated forms, enclosures, and/or heaters.
   3. Concrete cured in heated enclosures shall have heaters vented to prevent exposure of concrete and workmen to noxious gases.
   4. Frozen subgrade shall be thawed prior to concrete placement and snow and ice shall be removed from forms.
   5. Temperature of embedments in concrete must be heated to above 32°F prior to placing concrete

6. Heat the mixing water and then blend hot and cold water to obtain concrete no more than 10°F above the required temperature.
7. Heat the aggregates by circulating steam in pipes placed in the storage bins for air temperatures consistently below 32°F. When either water or aggregate is heated to over 140°F, combine them in the mixer first to obtain a maximum temperature of the mixture not to exceed 140°F in order to prevent flash set of the concrete.
8. Uniformly thaw aggregates far in advance of batching to prevent moisture variations in the stockpile.
9. Cover warmed stockpiles with tarps to retain heat.
10. Place air entraining admixture in the batch after the water temperature has been reduced by mixing with cooler solid materials.
11. Use wind screens to protect concrete from rapid cooling.
12. Place vertical pump lines inside the building, if possible, for concrete being pumped.
13. Maintain artificial heat as low as possible to reduce temperature stresses during cooling.
14. Avoid water curing of concrete except for parking garage structures. Apply the required curing compound to unformed surfaces as soon as possible to prevent drying of concrete from heated enclosures.
15. Delay form stripping as long as possible to help prevent drying from heated enclosures and to reduce damage to formed surfaces caused by premature stripping.
16. Provide triple thickness of insulating materials at corners and edges vulnerable to freezing.
17. Wrap protruding reinforcing bars with insulation to avoid heat drain from the warm concrete.
18. Gradually reduce the heat at the end of the heating period to reduce likelihood of thermal shock.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor rods for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp and finish concrete surfaces as scheduled.

E. Adhesive Anchors: All drilled holes for adhesive anchors shall be within six degrees of perpendicular to the surface of the concrete member.

3.13 INVESTIGATION OF LOW CONCRETE STRENGTH TEST RESULTS

A. Contractor Responsibility for Low Strength Concrete:
   1. If the average of any three consecutive strength tests falls below the required f'c for a class of concrete but no individual strength test is more than 500 PSI below the required f'c, the

Contractor shall immediately notify the Engineer by telephone or email and take immediate steps to increase the average of subsequent strength tests.

2. If any individual strength test falls more than 500 PSI below the required f'c, the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to assure that the load-carrying capacity of the structure is not jeopardized.

B. Additional Field Tests to Confirm Low Concrete Strengths:

1. The cost of all investigations of low-strength concrete, as defined by any individual strength test being more than 500 PSI below the required f'c, shall be borne by the Contractor.
2. Code-Prescribed Acceptance: The only accepted field-test methods of determining actual in-situ concrete strength is by the way of core tests as prescribed by ACI 318.
3. Non-Destructive Tests: If any individual strength test falls more than 500 PSI below the required f'c, the Engineer may request that non-destructive field tests be performed on the concrete in question using Swiss Hammer, Windsor Probe, or other appropriate methods as approved by the Engineer. Report the comparative test results of the suspect concrete under consideration with identical tests done on concrete of known strength and of the same class. The Engineer considers these test results as only approximate indicators of strength and may not necessarily, by themselves, resolve the low concrete strength issue. These test results will be considered as additional information by which to make an informed judgment. The Engineer reserves the right to accept the concrete based on the results of these approximate tests or order that core tests be taken as prescribed below. At the Contractor's option, the approximate non-destructive field-tests may be waived and core tests immediately initiated.
4. Core Tests: If, in the opinion of the Engineer, the likelihood of low-strength concrete is confirmed and it has been determined that the load-carrying capacity of the structure is significantly reduced as a result, the Engineer may request that core tests be taken from the area in question as directed by the Engineer. There shall be a minimum of three cores taken for each strength test more than 500 PSI below the required f'c in accordance with ASTM C 42. If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60° to 80°F, relative humidity less than 60 percent) for seven days before test and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and tested wet. The Contractor shall fill all holes made by drilling cores with an approved drypack concrete.
5. Acceptance Criteria for Core Test: Concrete in an area represented by core tests shall be considered adequate if the average of three cores is equal to at least 85% of the required f'c and no single core is less than 75% of the required f'c. If approved by the Engineer, locations of erratic core strengths may be retested to check testing accuracy.
6. Load Test: If the concrete strength is not considered adequate based on core tests and the structural adequacy remains in doubt, the Engineer may order a load test as specified in ACI 318 be conducted for the questionable portion of the structure.
7. Strengthening or Demolition of the Structure: If the structural adequacy of the affected portion of the structure remains in doubt following the load test, the Engineer may order the structure to be strengthened by an appropriate means or demolished and rebuilt at the Contractor's expense.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Areas:

1. Formed Surfaces: As required by the structural engineer, concrete surfaces requiring repairs shall include cracks and any other defects that affect the durability or structural integrity of the concrete. Voids, including honeycombing and rock pockets, and tie holes shall be repaired as required by the specified Surface Finish.

2. Unformed Surfaces: Concrete surfaces requiring repair shall include all surface defects such as crazing, cracks that penetrate to reinforcement or through the member, popouts, spalling, and honeycombs, or as required by the structural engineer.

B. Classification:
1. Structural Concrete Repair: Major defective areas in concrete members that are load carrying (such as shear walls, beams, joists and slabs), are highly stressed, and are vital to the structural integrity of the structure shall require structural repairs. Structural concrete repairs shall be made using a two-part epoxy bonder, epoxy mortar, or specified polymer repair mortar. The Engineer shall determine the locations of required structural concrete repairs.
2. Cosmetic Concrete Repair: Defective areas in concrete members that are non-load carrying and minor defective areas in load carrying concrete members shall require cosmetic concrete repair when exposed to view and not covered up by architectural finishes. Cosmetic concrete repairs may be made using a polymer repair mortar and compatible bonding agent. The Architect/Engineer shall determine the locations of required cosmetic concrete repairs. Stains and other discolorations that cannot be removed by cleaning and are exposed to view will require cosmetic repair. Cosmetic concrete repair in exposed-to-view surfaces will require Architect's approval prior to patching operation.
3. Slab Repairs: High and low areas in concrete slabs shall be repaired by removing and replacing defective slab areas unless an alternate method, such as grinding and/or filling with self-leveling underlayment compound or repair mortar is approved by the Architect/Engineer. Repair of slab spalls and other surface defects shall be made using epoxy products as specified above and as determined by the Engineer. The high strength flowing repair mortar may be used for areas greater than one inch in depth.

3.15 FIELD QUALITY CONTROL

A. Field Testing and Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with cast-in-place concrete.

END OF SECTION 033000

SECTION 033543.16 – POLISHED AND STAINED CONCRETE FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Polishing at interior concrete floor slabs at grade and elevated slabs, locations as indicated on drawings.
2. Topical staining and sealing polished interior concrete floor slabs in areas as indicated on drawings.
3. Concrete for polished concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Division 03 Section "Cast-in-Place Concrete."
4. Protection of completed polished concrete floors.

B. Related Sections:

1. Division 03 "Cast-in-Place Concrete" for concrete not designated as polished concrete.
2. Division 07 “Underslab Vapor Retarders” for sheet vapor retarders at concrete slab on grade.

1.3 DEFINITIONS

A. Honed: Honing typically provides a smooth, low-maintenance and durable finish. It is usually produced by grinding the concrete surface with abrasives. The term ‘honed’ is used to cover a level of grinding that produces a smooth but matt surface. Further grinding with progressively finer abrasives produces a ‘polished’ finish. The process of grinding exposes the aggregates which therefore have significant influence on the final appearance.

1.4 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 302.1R Guide for Concrete Floor and Slab Construction.

B. ASTM International:

1. ASTM C309 “Liquid Membrane-Forming Compounds for Curing Concrete.”
2. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.

C. Concrete Polishing Association of America (CPAA):

1. Specifications and Guidelines.
2. Position Papers.

D. National Floor Safety Institute (NFSI):

1. NFSI Test Method 101-A Standard for Evaluating High-Traction Flooring Materials, Coatings, and Finishes.

E. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M194 “Chemical Admixtures.”

1.5 PERFORMANCE REQUIREMENTS

A. Provide polished concrete flooring that has been selected, manufactured and installed to achieve the following:

1. Abrasion Resistance: ASTM C779, Method A, high resistance, no more than 0.008 inch wear in 30 minutes.
2. Reflectivity: Increase of 35% as determined by standard gloss meter.
3. Waterproof Properties: Rilem Test Method 11.4, 70% or greater reduction in absorption.
4. High Traction Rating: NFSI 101-A, non-slip properties.
5. Hardened Concrete Properties:

   a. Minimum Concrete Compressive Strength: 3500 psi.
   b. Normal Weight Concrete: No lightweight aggregate.
   c. Non-air entrained.
6. Placement Properties:

   a. Natural concrete slump of 4 1/2 inches - 5 inches. Admixtures may be used.
   b. Flatness Requirements: Refer to Division 03 “Concrete Finishing.”
7. Hard-Steel Troweled (3 passes) Concrete: No burn marks. Finish to ACI 302.1R, Class 5 floor.

   a. Coordinate with approved sample.
8. Minimum Dynamic Coefficient of Friction for Floors: For polished concrete walkway surfaces, provide products with the following values determined by testing identical products using the BOT-3000 to measure slip resistance of flooring, and the minimum requirement for floor surfaces in wet or dry conditions shall be:

   a. 0.42 for floors and stair treads.

   b. 0.51 minimum for ramp surfaces.
9. Curing Options:

   a. Membrane forming curing compounds (ASTM C309, Type 1, Class B, all resin, dissipating cure). Acrylic curing and sealing compounds are not recommended.
   b. Sheet membrane (ASTM C171); polyethylene film not recommended.
   c. Damp Curing: Seven day cure.

1.6 ACTION SUBMITTALS

A. Submit in accordance with provisions of Division 01 Section “Submittal Procedures.”

B. Inspection and Tests of Concrete Slabs: Contractor shall confirm/field verify the existing concrete wearing slab strength and notify Design Professional confirming that psi strength is sufficient for polishing concrete.

C. Product Data: Submit product data, including manufacturer's product sheet, for specified products.

1. Curing compound.
2. Staining products.
3. Preparation and concrete grinding procedures.
4. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties as cited in Performance Requirements.
5. Certificates:
   a. Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
   b. Letter of certification from the National Floor Safety Institute confirming the system has been tested and passed phase Two Level of certification when tested by Method 101-A.
   c. Current contractor's certificate signed by manufacturer declaring contractor as an approved installer of polishing system.
6. Manufacturer's Instructions: Manufacturer's installation instructions.
7. Product data for each grinding machine, including all types of grinding heads, dust extraction system, joint filler, impregnator, and any other chemicals used in the process.
8. Patching materials.
9. Floor Protection materials.

D. Shop Drawings: Indicate information on shop drawings as follows:

1. Typical layout including dimensions and floor grinding schedule.
2. Plan view of floor and joint pattern layout.
3. Hardener, densifier in notes.

E. Samples for Initial Selection: Submit four 12” x 12” samples showing finish.

1.7 INFORMATION SUBMITTALS

A. Qualification Data for Applicators and Manufacturers.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Repair materials.
2. Stain materials.
3. Liquid floor treatments.

C. Closeout Submittals

1. Warranty: Submit warranty documents specified.
2. Operation and Maintenance Data: Submit operation and maintenance data for installed products in accordance with Division 01 Section Closeout Procedures.
   a. Include:

1) Manufacturer's instructions on maintenance renewal of applied treatments.
2) Protocols and product specifications for joint filing, crack repair and/or surface repair.

1.8 QUALITY ASSURANCE

A. Field Sample Panels: After approval of verification sample and before casting concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, approximately 48 by 48 inches minimum, to demonstrate the expected range of finish, color, and appearance variations.

B. Comply with the requirements of ACI 301.

C. Installer Qualifications: Arrange for work of this section to be performed by an installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project. Installer shall be trained and approved by the concrete hardening and sealing material manufacturer.

1. Experience: Company with not less than 5 years experience in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce required Work.
2. Supervision: Maintain competent supervisor who is at Project during times specified Work is in progress, and, who is experienced in installing systems similar to type and scope required for Project.
3. Trade Association: Member in good standing of International Polished Concrete Institute IPCI.

D. Manufacturer Qualifications: Ensure manufacturer has minimum of 5 years experience in manufacturing products similar to or exceeding requirements of project.

E. CM/GC's Quality Control Plan: Submit a QC plan for polished concrete finishing within 10 calendar days after receipt of Notice to proceed.

F. Source Quality Control: Obtain each specified material from same source and maintain high degree of consistency in workmanship throughout Project.

G. Hardening Sealing Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

H. Regulatory Requirements. Provide polished concrete finishing that complies with NFSI Test Method 101-A Phase Two Level High Traction Material.

I. Mock-Ups:

1. Construct mock-ups at jobsite in accordance with Division 01 Section "Quality Requirements".
2. Mock-Up Size: One bay or of sufficient size to demonstrate finishes for each different polished floor finish at location(s) as directed by Design Professional and under conditions similar to those which will exist during actual placement.
3. Mock-up will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, and shine.

4. Construct mockup using processes and techniques intended for use on permanent work, including curing procedures. Include samples of control, construction, and expansion joints in sample panels. Mockup shall be produced by the individual workers who will perform the work for the Project.
   a. Retain samples of cements, sands, and aggregates used in mockup for comparison with materials used in remaining work.
   b. Aggregate selected must be tested to ensure it will accept polish.
   c. Schedule cut and shine level and finish coat.
   d. Edges should be included in mockup.
5. Allow 24 hours for inspection of mock-up before proceeding with work.
6. Use same personnel, including supervisors, which will perform work.
7. Show maximum variation that will exist in work.
8. Patching mockup: provide stained and patched concrete mockup for review by Design Professional.
9. Approval will be for compliance with approved submittals, exposed aggregates, and uniformity of sheen.
10. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Maintain approved mock-up in undisturbed condition as part of finished the completed Work.

J. Preinstallation Conference: Conduct a preinstallation conference at Project Site to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. The preinstallation conference shall include the concrete contractor, ready-mix producer, polishing CM/GC, testing agency, representatives of the Design Professional, and Owner. Comply with Division 01 Section - Project Meetings. Review the following:

1. Environmental requirements.
2. Scheduling and phasing of work.
3. Coordinating with other work and personnel.
4. Protection of adjacent surfaces.
5. Surface preparation.
6. Repair of defects and defective work prior to installation.
7. Cleaning.
8. Installation of polished floor finishes.
9. Application of liquid hardener, densifier.
10. Protection of finished surfaces after installation.

1.9 DELIVERY, STORAGE & HANDLING

A. General: Comply with hardener manufacturer’s instructions. Deliver materials in manufacturer's original packaging with identification labels and seals intact.

B. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

C. Concrete Slab Protection: Protect from petroleum stains during construction, including but not limited to the following:

1. Diaper hydraulic power equipment.
2. Restrict use of pipe cutting machinery.
3. Restrict placement of reinforcing steel on slab.
4. Restrict use of acids or acidic detergents on slab.

D. Waste Management and Disposal: Separate waste materials for recycling in accordance with Division 01 Section "Construction Waste Management". Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.10 PROJECT CONDITIONS

A. Installation Instructions: Comply with manufacturer's written instructions and recommendations.

B. Damage and Stain Prevention: Take precautions to prevent damage and staining of concrete surfaces to be polished.

1. Prohibit following over concrete surfaces to be polished:
   a. Pipe cutting operations.
   b. Ferrous metals storage.
2. Protect concrete surfaces to be polished from following:
   a. Petroleum, oil, hydraulic fluid, or other liquid dripping from equipment.
   b. Acids and acidic detergents.
   c. Painting activities.

1.11 ENVIRONMENTAL LIMITATIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting polishing operations.

B. Flatness and levelness:

1. Finish concrete shall have a minimum Floor Flatness rating of at least 50.
2. Finish concrete shall have a minimum Floor Levelness rating of at least 30.

C. Finish concrete shall be cured a minimum of 28 days.

D. Application of finish system shall take place a minimum of 21 days prior to fixture and trim installation and/or Material Completion.

E. Finish concrete area shall be closed to traffic during finish floor application and after application for the time as recommended by the manufacturer.

1.12 SEQUENCING

A. Sequence with Other Work: Comply with manufacturer's written recommendations for sequencing construction operations.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Source Limitations: Obtain each color, grade, finish, type, and variety of product from single source with resources to provide products of consistent quality in appearance and physical properties.

B. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

C. Provide products that comply with local regulations controlling use of volatile organic compounds (VOCs).

2.2 LIQUID DYES, DENSIFIERS AND POLISHES

A. Provide liquid dyes, densifiers and polishes from a single source. Do not “mix and match” from one manufacturer’s product line to another.

B. Available Manufacturers:

1. (Basis of Design) Krete-Tek Industries; Ghostshield Lithi-Tek 4500 and all accessory products.

2. Acceptable manufacturers include:

a. Sika Scofield Company
b. Sherwin Williams

C. Penetrating Dyes: Soluble dye with colorfast pigments, formulated to color interior concrete surfaces prior to being densified, sealed or ground and polished.

D. Densifiers: VOC-free, penetrating, semi-transparent liquid, improving the surface sheen and stain resistance of concrete.

E. Sealers: provide manufacturer’s compatible sealers; VOC compliant, UV stabilizers, breathable.

2.3 CONCRETE MIX

A. Slump of concrete shall be consistent throughout Project at 4-inches or less. At no time shall slump exceed 5-inches. If super plasticizers or mid-range water reducers are allowed, a test pour must be place to determine compatibility prior to placement.

B. Do not add calcium chloride to mix as it causes mottling and surface discoloration.

C. Limit percentage, by weight, of fly ash and slag cement to not more than 20 percent of the total cementitious materials.

D. Supplemental admixtures including air-entrainment and water-reduces, shall not be used unless approved by Design Professional.

E. Do not add water to the mix in the field.

2.4 FINISH FLOOR PROTECTION

A. Provide heavy-duty, non-staining, non-scratching, slip-resistant, multi-ply breathable, temporary floor protection allowing the concrete to properly cure and to protect against water, paint, mud and other construction-related surface damage.

B. Available Manufacturers and products: Provide one of the following or equal.

1. RAM Board; Temporary Floor Protection
2. (Basis of Design) SCOFIELD; Proguard Duracover.
3. Surface Shields; Builder Board.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Site Conditions: Examine concrete floor areas to receive polished concrete finishing for compliance with manufacturer’s written product data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and manufacturers printed data sheets

1. Verify that concrete substrate conditions, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete finishing materials.

B. Contractor shall verify Concrete Slab Performance Requirements:

1. Verify concrete is cured to 28 day, 3500 psi strength.
2. Verify concrete surfaces received a hard steel-trowel finish (3 passes) during placement.

3.2 CONCRETE

A. Install concrete according to requirements of Division 3 Section “Cast-In-Place Concrete” and the following:

1. Placement: Deposit concrete in a continuous operation that does not result in coarse aggregate segregation.

B. Do not add water to concrete mix in the field.

C. Surfaces shall be finished uniformly with the following finish:

1. Flatness of the slab must exceed 50.
2. Trowel: Precautions should be taken to ensure that the surface is uniformly troweled. Do not over-trowel or burn the surface.

3. Ground and Polished Concrete Surface: Precautions should be taken to insure the surface is in tolerances to perform this function.

3.3 PREPARATION FOR POLISHING

A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.

B. Examine surface to determine soundness of concrete for polishing.

C. Remove surface contamination in accordance with manufacturer's printed specifications and recommendations.

3.4 INSTALLATION

A. Floor Surface Polishing and Treatment: Provide polished concrete floor treatment in entirety of slab areas indicated on the Drawings. Provide consistent finish in all contiguous areas. Apply floor finish prior to installation of fixtures and accessories.

B. Grinding Concrete

1. Based on the hardness of the concrete polishing contractor shall start off with a 30 grit metal bond diamond to open up the concrete.
2. The next step shall utilize a 80 grit metal bond then a 120 grit metal bond diamond will follow as preparation for the polishing steps.

C. Aggregate Exposure:

1. Main Floors Preferred Aggregate Exposure: Class B – Fine / Sand Aggregate Finish: Remove not more than 1/16 inch of concrete surface by grinding and polishing resulting in majority of exposure displaying fine aggregate with no, or small amount of, medium aggregate at random locations.

2. Back of House Spaces Preferred Aggregate Exposure: Class A – Cream Finish: Polish Portland cement paste resulting in little or no aggregate exposure.

D. Polishing: Final Polished concrete floor finish Level 3 Gloss.

1. The polishing process will begin with a 100 grit transitional resin bond diamond.
2. The next two steps will be 200 and 400 grit resin bond diamonds.
3. A lithium based densifier is applied and worked in. The densifier will penetrate the capillaries and crystalize. This will harden the concrete and help maintain the shine.
4. The polishing process will be completed with a 800, 1500 and then a 3000 grit resin bond diamond.

E. Diamond polish concrete floor surfaces with power disc machine recommended by floor finish manufacturer. Sequence with coarse to fine grit using dry method.

1. Comply with manufacturer's recommended polishing grits for each sequence to achieve desired finish level. Level of sheen shall match that of approved mock-up.
2. Expose aggregate in concrete surface only as determined by approved mock-up.

3. All concrete surfaces shall be as uniform in appearance as possible.

F. Apply densifier as follows:

1. First coat at 250 SF/gal.
2. Second coat at 350 SF/gal.
3. Follow manufacturer's recommendations for drying time between successive coats.

G. Remove defects and re-polish defective areas.

H. Finish edges of floor finish adjoining other materials in a clean and sharp manner.

3.5 ADJUSTMENTS

A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.

1. Final Polished Sheen: Uniform gloss sheen using 3000 grit polishing heads.

B. Fill joints flush to surface.

3.6 STAINING

A. Newly placed concrete shall be at least 30 days old before staining. Verify with manufacturer’s written directions.

B. Prepare surfaces according to manufacturer's written instructions and as follows:

1. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.

   a. Do not use acidic solutions to clean surfaces.

2. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by grinding, sanding, or abrasive blasting. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
3. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
4. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F 710 to ensure pH is between 7 and 8 or as required by manufacturer.

3.7 FIELD QUALITY CONTROL

A. Design Professional shall engage qualified inspector to make inspections and take measurements of floor flatness measured in accordance with ASTM E 1155, Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

B. Dynamic Coefficient of Friction Testing: Contractor shall test polished finishes according to ANSI 137.1 Dynamic Coefficient of Friction (DCOF) Standard to confirm compliance with specified dynamic coefficient of friction.

3.8 PATCHING

A. Patch damaged concrete flooring with materials approved in advance by Design Professional. Test patch and stain in flooring area not visible prior to completing any additional patches.

3.9 FINAL CLEANING

A. Final cleaning in accordance with Division 01 Section "Closeout Procedures".

B. Mechanically scrub treated floors for seven days with soft to medium pads with approved cleaning solution.

C. Upon completion, Contractor must remove surplus and excess materials, rubbish, tools and equipment.

3.10 PROTECTION

A. Protect polished and stained concrete with temporary floor protection materials as in approved shop drawings and according to manufacturer's instructions.

B. NOTE: Do not penetrate the surface with any temporary railing or bracing materials except as approved by Design Professional and noted on approved shop drawings.

END OF SECTION 033543

SECTION 050513 -- SHOP-APPLIED PRIMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Shop-applied primer for field-applied high-performance and duplex steel coatings, and for all other ferrous metal surfaces.
2. Surface preparation for shop-applied primer for structural steel and structural galvanized steel.
3. Repair and restoration of damaged primer.
4. Supplementary components, accessories, and detail work necessary for a complete application, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:

1. Division 05 "Structural Steel Framing" for requirements for exposed structural steel.
2. Division 09 Section "High-Performance Special Coatings for Steel" for coating of galvanized metal surfaces, and coating of uncoated ferrous metal surfaces installed in SSPC Environmental Zones 1B and 2A identified as having a field-applied paint finish, including field-applied primers and spot primers.

1.3 REFERENCES

A. Abbreviations and Acronyms:

1. AISC: American Institute of Steel Construction.
2. DFT: Dry Film hickness.
3. HDG: Hot Dip Galvanized.
4. NACE: National Association of Corrosion Engineers.
5. NAAMM: National Association of Architectural Metal Manufacturers.
6. SSPC: The Society for Protective Coatings.

B. Definitions:

C. SSPC Environmental Zones:

1. Zone 0: Dry interiors where structural steel is embedded in concrete, encased in masonry, or protected by membrane or non-corrosive contact type fireproofing.
2. Zone 1A: Normally-dry interior or temporary protection.
3. Zone 1B: Normally-dry exteriors.

4. Zone 2A: Frequently wet by fresh water, including condensation, splash, spray, or frequent immersion.

D. Manufacturer: Means the primer manufacturer, unless otherwise indicated.

1.4 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's literature and technical data for each primer system.

1. Application instructions including mixing, surface preparation, recommended wet and dry film thickness, recommended application methods.
2. Manufacturer's recommendations for use; include limitations.

B. LEED Action Submittal:

1. Building Product Disclosure and Optimization:
   a. Leadership Extraction Practices
      1) Extended Producer Responsibility (EPR): Submit documentation indicating that manufacturers have a take back or recycling program for the product purchased.
      2) Recycled Content: For products having recycled content, indicate percentages by weight of post-consumer and pre-consumer recycled content.
      3) Include statement indicating distance to Project, cost for each regional material and the fraction by weight that is considered regional.

2. Indoor Environmental Quality, Low Emitting Materials: Building Products must be tested and compliant with the California Department of Public-Health (CDPH) Standard Method V1.1-2010, using the applicable exposure scenario.

1.5 INFORMATION SUBMITTALS

A. LEED Informational Submittals:

1. Building Product Disclosure and Optimization - Sourcing of Raw Materials:
   a. Raw Material Sources and Extraction Reporting: Submit Raw materials supplier corporate Sustainability Reports (CSRs); documenting responsible extraction; including extraction locations, long term ecologically responsible land use, commitment to reducing environmental harms from extraction and manufacturing processes, and a commitment to meeting applicable standards or programs that address responsible sourcing criteria

2. Building Product Disclosure and Optimization - Material Ingredients
   a. Material Ingredient Optimization: Submit manufacturer's Environmental Product Declaration (EPD) and at least one additional declaration.
   b. Product Manufacturer Supply Chain Optimization: Submit documentation from manufacturers for products that go beyond material ingredient optimization .

B. Certificate for Applicator's Qualifications: Submit certification from the manufacturer stating that the applicator is an approved applicator of the material for work of this Section.

C. Touch-Up Procedures: Submit primer manufacturer's recommended touch-up procedures and instructions.

D. Warranty Draft: Submit draft of warranty with required inclusions for review. Submit draft warranty with product data.

E. Contract Closeout Submittal: Submit warranty at time of Project Closeout; include warranty in "Warranties Manual".

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of shop primer used for the Project through one source from the same manufacturer.

1. Provide primers of the same generic chemistry as the specified products, and that also meet or exceed the specified performance requirements. Proposed substitutions that change the generic chemistry of specified primers are not permitted.
2. Specified thicknesses and coverage rates are minimum; where manufacturer's thickness recommendations differ from specified thickness and coverage rate, consult with manufacturer's technical representative, obtain manufacturer-prepared requirements, recommendations, or instructions in writing, and promptly distribute copies to the Design Consultant prior to starting work.

B. Quality Standard Requirements: Comply with requirements of NAAMM documents AMP 500, "Metal Finishes Manual" and AMP 504, "Finishes for Carbon Steel and Iron".

C. Applicator Qualifications: Only a firm certified by the AISC as having a current P3**-** Sophisticated Painting Endorsement (SPE) certification may apply metal primers to steel surfaces indicated to receive a field-applied high-performance coating.

1.7 COORDINATION

A. Coordination: Coordinate the surface preparation and shop priming of ferrous metal surfaces indicated to receive a field-applied paint coating or a high- performance special steel coating with the requirements and recommendations of the selected fireproofing, paint and high-performance steel coating manufacturer. Shop prime all steel surfaces except:

1. Members or portions of members scheduled to receive a field-applied cementitious fireproofing;
2. Members or portions of members embedded in concrete or mortar, except for the initial 2-inches;
3. Faying surfaces of connections using slip critical bolts;
4. Field welded surfaces, including flange surfaces to receive metal decking; and hot dip galvanized surfaces scheduled to retain a natural finish.
5. Indicate average dry film thickness (DFT) measurements for each primed item, along with method of taking measurement.

PART 2 - PRODUCTS

2.1 SHOP PRIMER FOR HIGH-PERFORMANCE COATINGS AT EXPOSED STEEL

A. Description: Zinc-rich aromatic urethane organic primer.

B. Acceptable Manufacturers: provide one of the following or equal:

1. Carboline Co.
2. PPG Industries, Inc.
3. Tnemec

C. Items must conform to the following:

1. Type: SSPC-Paint 20 Type II (Organic) zinc-rich primer.
2. Thickness: Apply to DFT of between 2.5 and 3.5 mils per coat, when measured in compliance with SSPC publication SSPC-PA 2.
3. Color: Reddish-gray or other standard color furnished by the primer manufacturer.

D. Performance Requirements:

1. Zinc Dust Pigment: ASTM D 520 Type III composition classification (maximum
2. 0.002 percent lead).
3. Dry Film Adhesion: At least an 800 psi pull, when tested in compliance with ASTM D 4541.
   a. Humidity Resistance: No blistering, cracking, rusting or delaminating of film after at least 1,000 hours exposure, when tested in compliance with ASTM D 4585.
   b. Salt Spray Resistance: No blistering, cracking, rusting or delaminating of film, and not more than 1/32-inch rust creep at scribe after at least 10,000 hours exposure, when tested in compliance with ASTM B 117.
   c. Minimum Slip Coefficient Rating: At least 0.50 (AISC Class B surface), when tested in compliance with ASTM A 490.

2.2 SHOP APPLIED PRIMER FOR DUPLEX COATINGS

A. Hot-Dipped Galvanized Coatings per Division 05 “Structural Steel Framing” and according to ASTM A 123/A 123M.

B. Surface Preparation: Refer to SPPC-16 and prepare by brush-off abrasive blasting.

2.3 SHOP PRIMER FOR ALL OTHER STEEL SURFACES

A. Description: Low VOC, rust-inhibitive, self-crosslinking hydrophobic acrylic primer for all other uncoated ferrous metal surfaces.

B. Manufacturers:

1. Carboline Co.
2. PPG Industries, Inc.
3. Tnemec

C. Items must conform to the following:

1. Thickness: Apply to DFT of 2.0 to 4.0 plus or minus 0.5 mils per coat, when measured in compliance with SSPC publication SSPC-PA 2. Provide 2 coats.
2. Color: Gray.

D. Performance Requirements:

1. Dry Film Adhesion: A minimum rating of at least 5B, when tested in compliance with ASTM D 3359.
2. Salt Spray Resistance: No blistering, cracking, rusting or delaminating of film and no rust creep at scribe after minimum 500 hours exposure, when tested in compliance with ASTM B 117.

2.4 ACCESSORIES

A. Spot Primer: For field touchup of surfaces primed as part of the work of this section, provide spot primer identical to the selected shop primer originally used to prime surfaces.

B. Flash Rust Inhibitor/Salt Remover:

1. Description: Additive that prevents flash rusting of wet abrasive- and water-blasted iron and steel surfaces, and of dry-blasted surfaces in a pressurized wash down.

C. Other Accessories: Provide other accessories and similar secondary items supplied, required, recommended, approved, or accepted by the primer manufacturer.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. General: Clean surfaces to be primed.

1. Remove dirt, dust, oil, grease, loose rust, mill scale, weld spatter, slag, flux deposits, and other deleterious materials that would negatively affect the quality of application, primer adhesion, durability, and performance.
2. Comply with the applicable SSPC and NACE publications indicated, and with manufacturer-prepared instructions, using manufacturer-furnished, recommended or approved materials and techniques.
3. To avoid surface contaminant pick-up, promptly prime prepared surfaces as soon as practicable after and within the same day as surface preparation.

B. Iron and Steel Surfaces:

1. SSPC Environmental Zones 0 and 1A Exposed-In-Service Conditions: Prepare surfaces in compliance with primer manufacturer-prepared instructions and SSPC- SP-3, “Power Tool Cleaning”.
2. SSPC Environmental Zone 1B Exposed-In-Service Conditions: Prepare surfaces in compliance with primer manufacturer-prepared instructions and SSPC-SP-11, “Power Tool Cleaning to Bare Metal”.
3. SSPC Environmental Zone 2A Exposed-In-Service Conditions: Prepare surfaces in compliance with primer manufacturer-prepared instructions and SSPC-SP-6/NACE 3, “Commercial Blast Cleaning”.

3.2 PRIMER APPLICATION

A. Promptly apply primer after surface preparation.

B. Apply primer in conformance with SSPC standard SSPC-PA 1, “Shop, Field, and Maintenance Painting of Steel”.

1. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
2. Stripe corners, crevices, bolts, welds, and sharp edges.
3. Apply two coats of primer to surfaces that will be inaccessible after assembly or erection.

C. Correction:

1. Correct deficiencies that do not conform to the Drawings or specified requirements, as determined by the manufacturer’s field representative and the Design Consultant.
   a. Correction of defective work is only permitted when both structural performance and visual appearance are not affected, and fire-resistive ratings are not compromised.
   b. Document both defective work and proposed corrections to the defective work, and then submit such documentation to the Design Consultant for review. Defective work submittals must include
      1) descriptions and locations of defective work;
      2) supporting sketches, diagrams, photographs, and other visual depictions of defective work; and
      3) similar documentation and visual depictions of Contractor-proposed corrections.
   c. Do not begin correction of defective work until after the Design Consultant's review of the defective work submittal is complete.
   d. With respect to the acceptance or rejection of corrected work, the Design Consultant's decision is final. Acceptance by the Design Consultant of corrected work is contingent upon
      1) corrections being performed skillfully,
      2) corrective work resulting in sound, permanent construction that is flush and seamless with adjacent surfaces;
      3) colors and textures matching adjoining and adjacent surfaces, without differentiation; and
      4) no visible evidence of correction nor any other apparent distinction or seam between original and corrected work.
2. Arrange and pay costs for either removing and re-installing or replacing items that are damaged or that cannot be satisfactorily corrected, as determined by the manufacturer’s field representative and the Design Consultant.

D. Repair:

1. Inspect surfaces coated to ensure that areas have not been missed. Apply primer to missed areas and holidays.
2. Repair or re-prime all surfaces where shop-applied primer has become damaged, scratched or chipped, or that cannot be satisfactorily, as determined and directed by the primer manufacturer’s representative and the Design Consultant.
   a. Clean damaged primer areas and prepare damaged primed surfaces and adjacent surfaces in compliance with primer manufacturer’s instructions and SSPC-SP-11 “Power Tool Cleaning to Bare Metal”.
   b. Sand smooth and re-clean.
   c. Spot-prime bare metal surfaces with specified primer applied to a minimum total spot primer DFT of 5 mils.
   d. Overlap undamaged primer areas with spot primer at least 2 inches.

3.3 FIELD QUALITY CONTROL

A. Site Tests and Inspections: The manufacturer's field representative determine primer DFT by spot-testing primed items under the guidelines outlined in SSPC-PA 2. Thickness measurements are made with a calibrated magnetic gauge to determine whether primer DFT conforms to the specified requirements.

B. Manufacturer Services: The work of this Section is subject to examination at the job site by the manufacturer's field representative.

1. The manufacturer's field representative randomly examines shop primer for defective materials, defective application, and conformance to the manufacturer's application instructions and other requirements.
2. During each field representative visit, itemize into a punch list all defects, improperly performing items, and nonconforming conditions and items.
3. For each item listed, record the field representative's recommendations for correcting each defect and improperly performing item, or for brining each nonconforming condition or item into conformance to the manufacturer's application instructions and other requirements.
4. Nonconforming Work: When testing reveals shop-primed items that are deficient or do not conform to the specified requirements, either make corrections acceptable to the Design Consultant, and then arrange and pay costs for re- testing until it can be demonstrated that all items perform properly and conform to the specified requirements, as determined by the Design Consultant; or re-prime

END OF SECTION 050513

SECTION 051200 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. Section includes labor, materials, services, equipment, and appliances required in conjunction with or related to the furnishing, fabrication, delivery, and erection of all structural steel, as defined below. Include all supplementary parts, members, and connections necessary to complete the structural steel work, regardless of whether all such items specifically are shown or specified on the drawings. Miscellaneous metal fabrication and steel deck are specified in other Division 05 sections.

B. Related Requirements:
1. Specification 014000 “Quality Requirements” for requirements of material testing and inspection.
2. Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with structural steel.
3. Specification 099600 “High-Performance Coatings” for surface preparation and priming requirements.

1.3 PRICE AND PAYMENT PROCEDURES

A. Alternates: Substitutions for the member sizes, type(s) of steel connection details, or any other modifications proposed will be considered by the Architect/Engineer only under the following conditions:
1. The request has been made and accepted prior to the submission of shop drawings. All substitutions shall be marked clearly and indicated on the shop drawings as a substitute.
2. There is a substantial cost advantage or time advantage to the Owner or that the proposed revision is necessary to obtain the required materials or methods at the proper times to accomplish the work in the time scheduled.
3. Sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by the Architect/Engineer, including cost reductions or savings in time to complete the work.
4. In no case shall such substitutions result in additional cost to the Owner.

1.4 REFERENCES

A. Definitions:
1. Erection Drawings: Field installation or member-placement drawings that are prepared by the Fabricator to show the location and attachment of the individual shipping pieces.
2. Erection-Bracing Drawings: Drawings that are prepared by the Erector to illustrate the sequence of erection, any requirements for temporary supports, and the requirements for

raising, bolting, and or/welding. These drawings are in addition to and separate from the Erection Drawings.

3. Heavy Shapes and Plates:
   a. Heavy Shapes:
      1) ASTM A6 structural shapes with a flange thickness greater than 2 inches.
      2) ASTM A6 structural shapes with a flange thickness equal to or greater than 1½ inches used in the Seismic Force Resisting System.
   b. Heavy Plates: Plates with thickness equal to or greater than 2 inches.
4. Long-span Steel: Custom-fabricated steel with spans that are greater than 100 feet.
5. Professional Engineer: A professional engineer who is licensed to practice engineering in the state where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material.
6. Shop Drawings: Drawings of the individual structural steel shipping pieces that are to be produced in the fabrication shop.
7. Structural Steel: Structural steel shall be defined as that work prescribed in Section 2.1 of AISC 303 and all steel support for elevator guide rails and catwalks (including support members and attached structural steel shapes and plates such as hangers, toe plates, and the grating walking surface).

B. Reference Standards:
   1. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified.
      a. All federal (OSHA), state, and local laws that govern safety requirements for steel erection and other requirements if more stringent than the codes and standards enumerated below. OSHA requirements include regulation 29 CFG 1926, Part R, “Safety Standard for Steel Erection”.
      b. AISC, “Steel Construction Manual.”
      c. ANSI/AISC 360, “Specification for Structural Steel Buildings.”
      d. ANSI/AWS D1.1, "Structural Welding Code – Steel.”
      e. ANSI/AWS D1.3, "Structural Welding Code – Sheet Steel.”
      f. ANSI/AWS D1.4, "Structural Welding Code – Reinforcing Steel.”
      g. Research Council on Structural Connections (RCSC), “Specification for Structural Joints using High-Strength Bolts.”
      h. The Society of Protective Coatings, "SSPC Painting Manual", Volumes 1 and 2.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Quality Control:
      a. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.
      b. The Contractor shall coordinate the fabrication and erection of all structural steel work with the work of other trades.
      c. The Fabricator alone shall be responsible for all errors of detailing, fabrication, and for the correct fitting of the structural members.
      d. The Fabricator shall coordinate connection details, joint fit-up procedures, and field adjustment requirements with Erector. The Contractor shall coordinate provision of all erection bolts, lifting lugs, or other devices required for erection with the Fabricator and the Erector and for interference with architectural finishes and constraints.
   2. Document Conflict and Precedence:

a. In case of conflict among documents, including architectural and structural drawings and specifications, notify Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.
b. Questions about Contract Documents: The Contractor shall notify promptly the Architect/Engineer whenever design of members and connections for any portion of the structure are not indicated clearly or when other questions exist about the Contract Documents. Such questions shall be resolved prior to the submission of shop drawings.

3. Materials and installed work may require testing and retesting, as directed by the governing building code or the Architect/Engineer, at any time during progress of work.
   a. The Contractor shall provide adequate notification to the Owner's Testing Agency of construction operation including the project schedule to allow the Testing Agency to schedule inspections. Failure to notify sufficiently may result in additional costs incurred by the Testing Laboratory that may be back-charge to the Contractor by the Owner.
   b. The Contractor shall cooperate with laboratory personnel, provide access to the work, and provide access to manufacturer's operations.
   c. The Contractor shall cooperate with the Owner's Testing Laboratory when Arbitration Testing and Inspection is called for due to a disagreement regarding the tension in installed bolts that have been inspected according to the Structural Testing and Inspections specification.
   d. The Contractor shall make adequate arrangement with the Owner's Testing Agency for inspection of material stockpiles and facilities.
   e. The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
   f. The Contractor shall furnish labor, equipment, and facilities as required for sampling and testing by the laboratory and other facilitates the required inspections and test.
   g. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Test not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See the Structural Testing and Inspections Specification.

B. Preinstallation Meetings:
   1. At least 14 days prior to beginning structural steel erection, the Contractor shall hold a meeting to review the detailed quality control and construction requirements and to determine the procedures for producing proper structural steel construction. Also, review requirements for submittals, status of coordinated work, and availability of materials. Establish work progress schedule and procedures for materials inspection, testing, and certification.
   2. The Contractor shall require responsible representatives of every party who is concerned with the structural steel work to attend the conference, including, but not limited to, the following:
      a. Contractor's Superintendent.
      b. Laboratory responsible for field quality control.
      c. Special Inspector or Laboratory responsible for shop inspection or testing.
      d. Structural steel detailer.
      e. Structural steel fabricator.
      f. Structural steel erector.
      g. Owner's Representative.
      h. Engineer.

3. Minutes of the meeting shall be record, typed, and printed by the contractor and distributed to all parties concerned within five days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:
   a. Owner's Representative.
   b. Architect.
   c. Engineer.
4. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least seven days prior to the scheduled date of the conference.

1.6 SUBMITTALS

A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products to show compliance with specifications, including the specified standards):
   1. Shrinkage-Resistant Grout.
   2. Welding Electrodes.
   3. Structural Steel Primer Paint.
   4. Inorganic or Other Protective Paint.
   5. Shear Studs.
   6. Direct Tension Indicators.
   7. Bearing pads.

B. Shop Drawings:
   1. Preliminary Connection Review: Submit preliminary details of proposed connections not less than 14 days in advance of the start of preparation of detailed shop drawings. Proposed variations from the details shown on the drawings will be considered and such variations must have preliminary approval from the Engineer prior to the preparation of detailed shop drawings. Failure to adhere to the requirements of this paragraph obligates the Contractor to take responsibility for any and all resulting delays in the detailing and fabrication of structural steel.
   2. Detailed Shop Drawings: Submit drawings showing complete details and schedules for fabrication and assembly of structural steel members. Drawings shall include the following minimum information:
      a. Details of cuts, connections, camber, holes, and other pertinent data.
      b. Indication of welds by standard AWS symbols, and show size, length, and type of each weld.
      c. Indication of type, size, and length of bolts, distinguishing between shop and field bolts. Identify the type of high-strength bolted connection (slip-critical, direct-tension, or bearing connections). Indicate locations of pretensioned bolts.
      d. Connection material specification and sizes.
      e. Joints or groups of joints in which a specific assembly order, welding sequence, welding technique, or other special precautions are required.
      f. Holes, flange cuts, slots, and openings shall be made as required by the structural drawings, all of which shall be properly located by means of templates.
      g. Setting drawings, templates, and directions for installation of anchor rods and other anchorages to be installed by others.
      h. Non-Destructive Testing (NDT) to be performed by the Fabricator, if any.
      i. A letter sealed by the Fabricator's Professional Engineer responsible for the design of any of the connections shown on the shop drawings attesting that the engineer has reviewed the shop drawings and that the connections detailed and shown on the shop drawings conform to the engineer's design.
      j. Identification of:
         1) Members and connections that are part of the Seismic Force Resisting System (SFRS).

2) Locations and dimensions of Protected Zones.
3) Demand Critical Welds.
4) Locations where weld backing is to be removed.
5) Locations where fillet weld reinforcement is to be added to steel backing left in place.
6) Locations where weld tabs are to be removed.
7) Access hole dimensions, surface profile, and finish requirements.
8) Gusset plates drawn to scale when they are detailed to accommodate inelastic rotation.

3. Erection Drawings: Submit complete erection drawings showing field installation and member-placing instructions for locating and attaching the individual shipping pieces.
4. Erection-Bracing Drawings: Submit, for record purposes only, complete erection-bracing drawings.
5. Shear Connector Placement Drawings: Provide drawings showing proper placement (longitudinal and transverse spacing) of shear connectors on each composite beam requiring such connectors. The drawings shall show the proper relationship of the shear connectors to the flutes in the steel deck and the arrangement of shear connectors along the span of the composite beam. Show the method of attachment of shear connectors and the proposed brand and model of equipment to be used.
6. All drawings submitted for review shall have blank space for a 2” high and 3.5” wide shop drawing stamp of the Engineer as part of the title block

C. Certificates:
1. Structural Steel: Submit for each type.
2. High-Strength Bolts: Submit for each type, including nuts and washers.
3. Bearing Pads.

D. Delegated Design Submittals:
1. Preliminary Connection Design Review: In conjunction with the Preliminary Connection Review submittal, the Fabricator’s licensed professional engineer shall submit example design calculations for each connection type not less than 14 days in advance of the start of preparation of detailed shop drawings.
2. Connection Design Submittals: The Fabricator’s licensed professional engineer shall submit complete design calculations show all information as specified in the “Connections” section under Part 2. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations.
3. Connection Design Validation Letter: The Fabricator’s licensed professional engineer responsible for the design of any of the connections shown on the shop drawings shall submit a letter that is sealed attesting that the connection design engineer has reviewed the shop drawings and that the connections detailed and shown on the shop drawings conform to the engineer’s design.
4. Long-Span Steel Erection Design Submittals: Submit calculations and drawings, prepared under the supervision of the Erector’s licensed professional engineer, for the final erection procedure.

E. Test and Evaluations Reports: Submit certified reports of tests required by this Specification. Include data on type(s) of tests conducted and test results.

F. Field Quality Control Submittals:
1. Surveys: Submit for each survey required.

G. Special Procedure Submittals:
1. Long-Span Steel Erection Procedure: Submit a written, detailed erection procedure for the long-span steel system that has been reviewed and approved by the General Contractor,

Fabricator, Steel Erector, and the Erector's licensed professional engineer. Procedure shall be sealed by the Erector's engineer.

H. Qualification Statements:
1. Submit qualification data, including required certifications, for firms and persons specified in the "Qualifications" section under Part 1, to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.
3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in the "Qualifications" section under Part 1. If recertification of welders is required, retesting will be at Contractor's responsibility.
4. A fabricator that is registered with the local building official and is approved to perform fabrication without special inspection shall submit a certificate of compliance stating that the work was performed in accordance with the approved construction documents.

I. Minutes of Preinstallation Meeting: Submit for review.

1.7 QUALITY ASSURANCE

A. Qualifications:
1. Fabricator:
   a. The structural steel fabricator shall have not less than 10 years of experience in the successful fabrication of structural steel including not less than three projects using heavy trusses.
   b. The structural steel fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant in Category STD, Standard for Steel Building Structures.
   c. The structural steel fabricator must be registered and approved by the local building official to perform fabrication work without special inspection. Should the fabricator not be so approved, the fabricator shall reimburse the Owner for the cost of the special inspections required by the local building official.
2. Detailer:
   a. The structural steel detailer shall have not less than five years of experience in the successful detailing of structural steel similar to this project including experience in selecting or completing structural steel connection details using information found in tables in the AISC "Steel Construction Manual.
   b. The structural steel detailer firm shall be certified under the Quality Procedures Program of the National Institute of Steel Detailing. The project shall be detailed by qualified structural steel detailers who are either personally certified under the National Institute of Steel Detailing as a Class I or Class II Detailer in the Structural/Miscellaneous discipline or are supervised by a detailer certified as a Class I Senior Detailer in the Structural/Miscellaneous discipline.
3. Erector:
   a. The structural steel erector shall have not less than five years of successful experience in the erection of structural steel of a similar nature to this project.
   b. The structural steel erector must participate in the AISC Erector Certification Program and be designated an AISC Certified Steel Erector.
   c. The structural steel erector shall have not less than five years of successful experience in the erection of structural steel including not less than three projects using heavy trusses.

4. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code – Steel".
5. Professional Engineer:
   a. The Professional Engineer employed by the Fabricator for connection design shall be experienced in the specific area of structural steel connection design with demonstrated experience of not less than three projects of similar scope and complexity.
   b. The Professional Engineer employed by the Erector for preparation of Erection Bracing Drawings shall be experienced in the specific area of structural frame bracing during erection design with demonstrated experience of not less than three projects of similar scope and complexity.
6. Specialty Welding Consultant: The welding consultant employed by the Fabricator shall be a licensed Professional Engineer registered in the state where the project is located and shall have a minimum of five years of experience in weld engineering.
7. Independent Testing Laboratory:
   a. Any testing laboratory retained to perform tests that are required by this specification shall meet the basic requirements of ASTM E 329 and shall submit to the Owner, Architect, and Engineer evidence of current accreditation from the American Association for Laboratory Accreditation, the AASTHO Accreditation Program or the "NIST" National Voluntary Laboratory Accreditation Program.
   b. The Testing Laboratory shall be an Approved Agency by the Building Official to perform Special Inspections and other tests and inspections as outlined in the applicable building code.
   c. Tests and inspections shall be conducted in accordance with specified requirements, and if not specified, in accordance with the applicable standards of the American Society for Testing and Materials or other recognized and accepted authorities in the field.
   d. Qualification of Welding Inspectors:
      1) Inspectors performing visual weld inspection shall meet the requirements of AWS D1.1 Section 6.1.4. Inspectors shall have current certification as an AWS Certified Welding Inspector (CWI). Assistant inspectors, if any, shall be supervised by an Inspector and shall be qualified by training and experience to perform the specific functions to which they are assigned.
      2) Inspectors performing nondestructive examinations of welds other than visual inspection (MT, PT, UT, and RT) shall meet the requirements of AWS D1.1, Section 6.14.6.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor rods and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time so as not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. Do not store materials on structure in a manner that might exceed allowable loads on or cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by Architect/Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel:
   1. All hot rolled steel plates, shapes, sheet piling, and bars shall be new steel conforming to ASTM A 6.
   2. Comply with the provisions of the following ASTM Specifications as appropriate for the grades and types, and at the locations as specified on the drawings:
      a. Structural Steel Wide Flange and WT Shapes: High Strength Steel, ASTM A 992.
      b. M-Shapes, S-Shapes, and Channels: Carbon Steel, ASTM A 36.
      c. M-Shapes, S-Shapes, and Channels: High Strength Steel, ASTM A 572, Grade 50.
      d. Angle Shapes: Carbon Steel, ASTM A 36.
      e. Structural Steel Plates and Bars: Carbon Steel, ASTM A 36.
      f. Structural Steel Plates and Bars: High Strength Steel, ASTM A 572, Grade 50.
      g. Steel Pipe: ASTM A 53 (Type E or S) Grade B (Fy = 35 ksi).
      h. Round HSS: ASTM A 500 Grade B (Fy = 42 ksi) or ASTM A 501 with written approval from the Engineer.
      i. Round HSS: ASTM A 500, Grade C (Fy = 46 ksi).
      j. Square and Rectangular HSS: ASTM A 500, Grade B (Fy = 46 ksi).
   1. Requirements for Heavy Shapes and Heavy Plates in Welded Connections. Heavy Shapes and Heavy Plates shall have a Charpy V-Notch toughness of 20 ft-lb or greater at 70 F, established by testing. The impact test shall comply with ASTM A 673, Frequency P.
      a. Heavy Shapes shall be supplied with Charpy V-Notch impact test results in accordance with ASTM A 6, Supplementary Requirement S30, “Charpy V-Notch Impact Test for Structural Shapes: Alternate Core Location.”
      b. Heavy Plates shall be supplied with Charpy V-Notch impact test results in accordance with ASTM A 6, Supplementary Requirement S5, “Charpy V-Notch Impact Test”.
   2. Connection Material: Unless noted otherwise on the drawings, column stiffener plates and doubler plates at moment connections shall be the same grade of steel as the beam connecting the column (highest grade if more than one grade is used). All other connection material except as noted otherwise on the drawings including bearing plates, gusset plates, stiffener plates, filler plates, angles, etc. shall be A36 steel unless a higher or matching grade of steel with the members connected is required by strength or stiffness calculations and provided the resulting sizes are compatible with the members connected.
   3. Structural Steel Surfaces: For fabrication of work which will be exposed to view in the completed structure, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

B. Structural Bolts and Threaded Fasteners: Structural bolts and threaded fasteners shall comply with the following ASTM Specifications as appropriate for the types and at the locations as specified on the drawings:
   1. ASTM F 3125 Grade A325 Type 1.
   2. Twist-Off-Type Tension-Control Bolt Assemblies:
      a. Bolts that are manufactured to conform to ASTM F 3125 Grade F1852.
      b. Bolts that are manufactured to conform to ASTM F 3125 Grade F2280.
      c. Subject to conformance with specified requirements, acceptable manufacturers include but are not limited to:
         1) Nucor Fastener, A Division of Nucor Corporation.
         2) Lake Erie Screw Corp.

3) Vermont Fasteners Manufacturing.
4) Lohr Structural Fasteners.

3. Threaded Round Stock:
   a. ASTM A 36.
   b. ASTM A 572 Grade 50 (to 2 inches in diameter).
   c. ASTM A 572 Grade 42 (greater than 2 inches and up to six inches in diameter).
   d. ASTM A 588 (corrosion resistant).
   e. ASTM A 354 Grade BD, 130 ksi (to 2 ½ inches in diameter).
   f. ASTM A 354 Grade BD, 115 ksi (greater than 2 ½ inches to 4 inches in diameter).
   g. ASTM A 354 Grade BC, 109 ksi (to 2 ½ inches in diameter).
   h. ASTM A 354 Grade BC, 99 ksi (greater than 2 ½ inches to 4 inches in diameter).
4. Bolts and Nuts, High Strength Bolts: Bolts and nuts for all high strength bolts shall be heavy hex head conforming to ANSI Standards B18.2.1 and B18.2.2 respectively. Nuts shall conform to ASTM A 563.
5. Washers: All washers shall be circular, flat and smooth and shall conform to the requirements of Type A washers in ANSI Standard B23.1. Washers for high strength bolts shall be hardened and conform to ASTM F 436. Beveled washers for American Standard Beams and channels shall be square or rectangular, shall taper in thickness (16 2/3% slope) with an average thickness of 5/16". When an outer face of a bolted part has a slope greater than 1:20 with respect to a plane normal to the bolt axis, a beveled washer shall be used. Washers to be used with A490 bolts larger than 1 inch in diameter and installed over oversized or short-slotted holes and other similar situations shall conform to ASTM F 436 except with 5/16 inch minimum thickness.
6. Zinc-Coated Bolts: ASTM F 3125 Grade A325 bolts, with their nuts and washers, that are used to connect steel called for on the drawings or in the specifications as hot-dip galvanized after fabrication shall be zinc-coated either by the hot-dip process in accordance with ASTM A 153, Class C or by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. The bolts, nuts, and washers shall all be zinc-coated using the same process and they shall be considered together as an assembly and shall be tested and shipped together as such. Comply with all the requirements of ASTM F 3125 Grade A325 and ASTM A 563 as they relate to zinc-coated materials. ASTM F 1852 bolts with their nuts, and washers shall be zinc-coated only by the mechanical deposition process in accordance with ASTM B 695, Class 50, Type 1. Do not zinc-coat ASTM F 3125 Grade A490 bolts.
7. Direct Tension Indicators: Compressible washer-type direct-tension indicators conforming to ASTM F 959.
   a. Subject to conformance with specified requirements, acceptable manufacturers include but are not limited to:
      1) Applied Bolting Technology.
      2) Turnasure, LLC.
8. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts will not be allowed.
9. New Bolts: All bolts shall be new and shall not be reused.

C. Electrodes for Welding:
   1. Provide electrodes that comply with AWS D1.1, "Structural Welding Code - Steel" and that can produce welds that have a minimum Charpy V-notch toughness of 20 ft-lbs at 40° F, unless noted otherwise in these specifications or on the drawings.
   2. Electrodes for various welding processes shall be as specified below:
      a. SMAW:
         1) E70XX low hydrogen.
      b. SAW:
         1) F7X-EXXX.
      c. GMAW:

1) ER70S-X.

d. FCAW:
   1) E7XT-X.

3. Electrodes shall be compatible with parent metal joined.

D. Headed Studs used as Anchors for Structural Steel Plates and Members connecting to Concrete: AWS Type A studs manufactured in conformance with ASTM A 29 with a minimum tensile strength of 61,000 psi of sizes as specified on the drawings.

E. Headed Studs used as Composite Member Shear Connectors: AWS type B studs manufactured in conformance with ASTM A 29 with a minimum tensile strength of 65,000 psi of sizes as specified on the drawings.

F. Deformed Bar Anchors: 3/8” to 5/8” diameter AWS Type C studs manufactured in conformance with ASTM A 1064 with a minimum yield strength of 70,000 psi and a tensile strength of 80,000 PSI. 3/4" or larger diameter, ASTM A 706 bars of equal size with welds to steel substrate that develop the full strength of the anchor. ASTM A 615 reinforcing bars may not be substituted for deformed bar anchors. Reinforcement shall be approved by the ICC-Evaluation Service, Inc and shall have the Evaluation Service Report submitted for Engineer review. The following are acceptable products, provided that their Evaluation Service Reports are still valid at the time of intended use on the project:
   a. Nelson Stud Welding, Inc.; Nelson D2L Deformed Bar Anchor Studs (ESR-2907).
   b. Tru-Weld Division, TFP Corporation; Deformed Bar Anchors (ESR-2823).

G. Anchor Rods:
   1. All anchor rods shall conform to ASTM F 1554. unless noted otherwise on the drawings and shall be of the yield strength as specified below as appropriate for the types and at the locations as specified on the drawings:
      a. Grade 55 (1/4 inch to 4 inches in diameter), complying with Supplementary Requirement S1 of ASTM F 1554.
      b. Grade 36, (1/4 inch to 4 inches in diameter). Substitution for Grade 36 anchor rods with Grade 55 anchor rods shall only be permitted provided the Grade 55 anchor rods comply with Supplementary requirements S1 of ASTM F 1554.
      c. Grade 105 (1/4 inch to 3 inches in diameter).
   2. Anchor rods used with galvanized baseplates shall be galvanized.
   3. Nuts: All nuts with anchor rods shall be heavy hex head conforming to ASTM A 563.
   4. Washers: Unless indicated otherwise, washers for all base plates shall be in accordance with the AISC “Steel Construction Manual”, Table 14-2 with holes 1/16” larger than the anchor rod diameter. Washers shall conform to ASTM A 36 steel.

H. Structural Steel Primer Paint:
   1. Primer paint shall produce a Class B coating on all painted faying surfaces that are a part of a slip-critical connection as noted on the drawings; surface prepared according to SSPC-SP-6 (Commercial Blast Cleaning) and shall be of the following types.
      a. Organic zinc-rich primer utilizing either an epoxy or urethane binder with a minimum volume solids ratio of 50 percent with a minimum zinc content of 80 percent by weight in the dry film. Apply primer at a rate to achieve a dry film thickness of 3.0 to 4.0 mils. The primer shall comply with the AISC Class B slip critical requirement. (SSPC-SP6 Commercial Blast Cleaning).
      b. Ethyl Silicate Inorganic zinc-rich primer with a minimum volume solids ratio of 60 percent and with a minimum zinc content of 75 percent by weight in the dry film. The primer shall comply with the AISC Class B slip critical requirement. (SSPC-SP6 Commercial Blast Cleaning).
   2. Unless noted otherwise, primer paint shall be one of the following types with the indicated surface preparation:

a. SSPC-Paint 25.1, Type II; zinc oxide, raw linseed oil and alkyd primer, surface prepared according to SSPC-SP-2 (Hand Tool Cleaning) unless noted otherwise in this specification.
b. Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664, surface prepared according to SSPC-SP-2 (Hand Tool Cleaning) unless noted otherwise in this specification. The contractor is responsible for supplying a paint that complies with the VOC requirements of all local governing agencies.
c. SSPC-Paint 23 acrylic primer, surface prepared according to SSPC-SP-6 (Commercial Blast Cleaning).
d. Hyrdrophobic Acrylic Polymer with dry film thickness of not less than 2.0 mils: Tnemec Series 30, Spra-Saf EN or Sherwin Williams, Spraylastic Exterior Waterborn Dryfall (SSPC-SP6 Commercial Blast Cleaning).

3. Refer to Architect's drawings and specifications for final paint finish requirements of structural steel. Primer paint shall be compatible with final paint requirements.

I. Non-Shrink Grout: Provide grout type(s) as specified on the drawings:

1. Non-Metallic Non-Shrink Grout: Premixed, non-corrosive, non-staining product containing Portland cement, silica sands, shrinkage compensating agents, and fluidity improving compounds. Conform to ASTM C 1107. Provide the minimum strength as shown below as determined by grout cube test at 28 days:
   a. 6,000 PSI for supporting concrete 3,000 PSI and less.
   b. 8,000 PSI for supporting concrete greater than 3,000 PSI and less than or equal to 4,000 psi.
   c. Unless noted otherwise on the drawings, grout strength for supporting concrete greater than 4,000 PSI shall be 8,000 PSI.

   Subject to conformance with specified requirements, acceptable non-shrink grouts include:
   a. L&M Construction Chemicals, Inc.; Crystex and Duragrout.
   b. Dayton-Superior Corporation; Sure Grip High Performance Grout and 1107 Advantage Grout.
   c. BASF Construction Chemicals; Masterflow 555 and Set Grout.
   d. U.S. Grout Corp.; Five Star Grout.
   e. The Euclid Chemical Company; NS Grout.
   f. Hilti, Inc.; CG 200 PC.
2. High Flow, Non-Metallic Grout: Use high-flow grout where high fluidity and/or increased placing time is required and for base plates that are larger than 10 square feet. The factory pre-mixed grout shall conform to ASTM C 1107, "Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under an 18" x 36" base plate. Provide one of the following:
   a. The Euclid Chemical Co.; Hi-Flow Grout.
   b. BASF Construction Chemicals; Masterflow 928.

J. Grating: Welded steel bar grating of the type, depth, and finish noted on the drawings capable of carrying not less than the stated live load and deflecting not more than span/360 under that load.

K. Hot-Dip Galvanizing:

1. Scope: All structural steel items and their connections permanently exposed to exterior conditions or that are within areas of unconditioned airspace, whether specified on the drawings or not, shall be hot-dip galvanized after fabrication unless indicated on the drawings to receive a primer and/or finish coat. Such items include, but are not limited to:
   a. Base plates and anchor rods supporting galvanized members.

b. Shelf angles.
c. Parapet wall supporting members.
d. Screen wall supporting members.
e. Window washing support members.
f. Exterior covered walkways.
g. Embedded plates in concrete exposed to unconditioned airspace.
h. Garage guardrail steel and connections.
i. Cooling tower support steel.
j. Building skin support steel exposed to moisture outside the exterior waterproofing surface.
k. Examine the architectural and structural drawings for other items required to be hot-dip galvanized.

2. Zinc-coat all ASTM F 3125 Grade A325 bolts nuts, and washers used in the connection of such steel. Field welded connections shall have welds protected and the exposed portions of ASTM F3125 Grade A490 bolts, nuts, and washers shall be protected with galvanizing repair paint.
3. Surface Preparation: All steel to be hot-dip galvanized shall undergo the following surface preparation as specified by the Society for Protective Coatings (SSPC), Volume 2.
   a. Remove all grease, oil, grime and foreign contaminants by thorough cleaning with an alkaline or organic solvent followed by thorough rinsing in cold water.
   b. Remove scale by pickling in diluted sulfuric or hydrochloric acid. Pickling shall be followed by a rinse in warm water and a second rinse in cold water. As an alternative to pickling, the steel may be white metal blast cleaned according to SSPC-SP-5.
   c. Dip in a flux solution of zinc ammonia chloride followed by drying at room temperature.
4. Zinc Coating: The zinc coating for steel shapes and plates shall conform to ASTM A 123. Weight of zinc coating per square foot of surface for 1/8 inch and 3/16 inch thick steels shall average not less than 3.0 mils with no individual thickness less than 2.6 mils. The coating weight shall average not less than 3.9 mils for 1/4" thick and heavier steel with no individual thickness less than 3.3 mils.

L. Galvanizing Repair Paint: Galvanizing repair paint shall be "ZRC Cold Galvanizing Compound" as manufactured by ZRC Chemical Products or a paint complying with SSPC-Paint 20, Level 1.

2.2 FABRICATION

A. Structural steel members for which shop drawings have not been reviewed shall not be fabricated. Any steel detailed or fabricated prior to the Initial Survey from Part 3 below is at contractor's risk.

B. All fabricated material and connections shall fit within architectural constraints.

C. The omission from the shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though the shop drawings may have been reviewed.

D. Shop Fabrication and Assembly:
1. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specification and as indicated on approved final shop drawings. Provide camber in structural members where indicated.
2. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
3. Milled surfaces of built-up sections shall be completely assembled or welded before milling.

4. Fitted stiffeners shall be fabricated neatly between flanges, and the ends of stiffeners shall be milled or ground to secure an even bearing against abutting surfaces. All milled or ground joints shall bear throughout their contact length.

E. Dimensional Tolerances: Dimensional tolerances of fabricated structural steel shall conform to Section 6.4 of the AISC Code of Standard Practice.

F. Camber:
1. Camber of structural steel members and trusses is indicated on the drawings. Camber shall be measured in the Fabricator's shop in the unstressed condition, prior to erection. The Fabricator shall provide camber measurements of all beams and a report to the Testing Laboratory confirming this has been done.
2. Where possible, camber of beams shall be applied by a cold bend process.
3. The local application of heat may be used to introduce or correct camber, curvature, or straightness provided the temperature of the heated area, as measured by temperature crayons or other approved means, does not exceed 1,200°F.
4. Where indicated on the drawings in a camber diagram, cantilever or double cantilever beams shall be cambered for the main span and cantilever end separately, either by a staged cold bending process or by the application of heat.
5. Beams and trusses detailed without specified camber shall be fabricated so that after erection any natural camber due to rolling or shop fabrication is upward.
6. Truss Camber Tolerances: Unless noted otherwise, the tolerance for any specified camber point shall be plus or minus 1/1600 (three-quarter inch per 100 feet) of the distance from the nearest specified support point.

G. Splices in Structural Steel: Splicing of structural steel members in the shop or the field is prohibited without prior approval of the Engineer. Any member having a splice not shown and detailed on approved shop drawings will be rejected.

H. Compression Joints: Ends of columns, except as otherwise noted, and other compression joints at splices and other connections as noted on the drawings which depend on contact bearing as part of the splice strength shall be finished to bear in accordance with AISC Specification M2.6 so as to provide complete true bearing in accordance with AISC Specification M4.4.

I. Cutting: Manual oxygen cutting shall be done only with a mechanically guided torch. An unguided torch may be used provided the cut is not within 1/8 inch of the finished dimension and final removal is completed by means such as chipping or grinding to produce a smooth surface quality free of notches or jagged edges. All corners shall be smooth and rounded to a minimum 1/2" radius.

J. Anchor Rods: Furnish anchor rods and other connectors required for securing structural steel to foundations and other in-place work. Furnish 1/8" minimum steel templates for presetting bolts and other anchors to accurate locations.

K. Large Plates to be Embedded in Concrete: For steel plates that are larger than 24"x24" and are to be embedded horizontally in and at the top surface of concrete, provide one-inch diameter holes to prevent trapped air underneath plates and to achieve full consolidation. The location of holes shall be shown on the shop drawings and shall not impair the strength of the plate.

L. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members as shown on the contract documents, and/or the final shop drawings.
1. Provide specialty items as indicated to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

M. Lifting and Erection Devices: The Fabricator shall be responsible for designing, detailing, and furnishing all lifting devices and erection aids required for erection. Such devices shall be removed after erection if they interfere with architectural finish requirements.

N. Drainage Holes: Provide 1 inch diameter drainage (weep) holes in all members (trusses, girders, beams, etc.) exposed to weather where rain water could collect (at low points and/or behind dams caused by connections, stiffener plates, etc.). Show all holes on shop drawings for review by the Engineer.

O. Requirements for Heavy Shapes and Heavy Plates: Heavy Shapes and Heavy Plates shall meet the following requirements:
1. Cutting: Preheating is required. Preheat temperature shall be sufficient to prevent cracking. The minimum preheat temperature is 150 degrees F through the entire thickness; higher preheat shall be provided if necessary to prevent cracking.
2. All cut edges shall be free of gouges and notches.
3. Edge preparations: Copes, cuts, weld access holes, and other flame-cut edges within 12” of a groove weld, hole, or discontinuity in that section shall be ground to bright metal with a surface roughness not exceeding 1000 micro-inches and tested for cracks using the dye penetrant method.

2.3 WELDING

A. Code: All shop and field welding shall conform to all requirements in the "Structural Welding Code – Steel", ANSI/AWS D1.1, as published by the American Welding Society (AWS).

B. Welder Certification: All shop and field welders shall be certified according to all the applicable AWS procedures for the welding process and welding position used. Each welder shall be assigned an identifying symbol or mark and all shop and field welded connections containing complete or partial joint penetration welds, multi-pass fillet welds, and fillet welds greater than 5/16” shall be identified by the symbol or mark of the welder responsible for the connection.

C. Minimum Size and Strength:
1. Fillet Welds: Minimum size of fillet welds shall be as specified in Table J2.4 in AISC Specification, Chapter J.
2. Partial-Penetration Groove Welds: The minimum effective throat thickness of partial-penetration groove welds shall be as specified in Table J2.1 in AISC Specification, Chapter J.
3. Minimum Strength of Welded Connections: Except as specified below in "Connections" or noted otherwise on the drawings, all shop and field welds shall develop the full tensile strength of the member or element joined. All members with moment connections as indicated on the drawings shall be welded to develop the full flexural capacity of the member, unless noted otherwise on the drawings.

D. Filler Metal Requirements: Weld metal shall be as specified in Table J2.5 in AISC Specification, Chapter J and other requirements of this specification.

E. Welding Procedure Specification:

1. All welding shall be performed in accordance with a Welding Procedure Specification (WPS) as required in AWS D1.1 and reviewed by the Owner's Testing Laboratory and by the Architect/Engineer. The WPS variables shall be within the parameters established by the filler-metal manufacturer. Engage the services of an independent Testing Laboratory to provide the qualification testing required by AWS D 1.1, Chapter 4, part B to qualify any non-prequalified WPS needed for the project. The independent Testing Laboratory shall prepare Welding Procedure Qualification Records (WPQR) documenting the successful qualification of each Welding Procedure Specification.

F. Welding Procedures:
1. All welding processes shall comply with the requirements of ANSI/AWS D1.1 unless noted otherwise.
2. Built-up sections assembled by welding shall be free of warpage and all axes shall have true alignment.
3. Welds not specified shall, if possible, be continuous fillet welds developing the minimum strength, as specified above, using not less than the minimum fillet welds as specified by AISC.
4. The toughness and notch sensitivity of the steel shall be considered in the formation of all welding procedures to prevent brittle and premature fracture during fabrication and erection.
5. The Welding Procedure Specification shall be followed without deviation unless specific approval for change is obtained from the Owner's Testing Laboratory and the Architect/Engineer.
6. Before welding, particular attention shall be paid to surface preparation, fit up, and cleanliness of surfaces to be welded.
7. Minimum preheat and interpass temperatures for structural steel welding shall be as specified in ANSI/AWS D1.1, except that no welding shall be performed when the ambient temperature is lower than 0 degrees F. The temperature shall be measured from the side opposite that upon which the preheat is applied.
8. The heat, input, length of weld, and sequence of weld shall be controlled to prevent distortions. The surfaces to be welded and the filler metals to be used shall be subject to inspection before any welding is performed.
9. Welds shall be sound throughout. There shall be no crack in any weld or weld pass. Welds shall be considered sound if they conform to AWS requirements, as confirmed by non-destructive testing.
10. Welds shall be free from overlap.
11. Craters shall be filled to the full cross section of the welds.
12. For high-strength low-alloy steels, follow welding procedures as recommended by steel producer for exposed and concealed connections.
13. Fabricator and Erector shall coordinate welding responsibility at all welded joints.

G. Stress Relieving: All welding sequences shall be such as to reduce the residual stresses due to welding to a minimum value. If high residual stresses are present, stress relieving of joints shall be required. Welded connections shall be detailed and designed to minimize the accumulation and concentration of through-thickness strains due to weld shrinkage.

2.4 BOLTING

A. Bolt Diameter: Minimum bolt diameter shall be 3/4 inch. The difference in diameter between bolts of differing sizes used on the project shall be not less than ¼".

B. Connection Type: Unless noted otherwise on the drawings, all bolted connections shall be snug-tightened using high-strength bolts in standard holes (hole diameter nominally 1/16 inch greater

than the nominal bolt diameter) with threads included in the shear planes. Notwithstanding, the contractor shall be responsible to adhere to provisions of ANSI/AISC 360 Section J1.10, which lists circumstances under which certain connections require pretensioned high strength bolts.

C. Oversize, Short-Slotted and Long-Slotted Holes: The dimensions and washer requirements of oversize, short-slotted, and long-slotted holes shall conform to ANSI/AISC 360 Table J3.3.

D. Fastener Tension:
   1. High strength bolts in snug-tightened joints shall be tightened to a snug tight condition only. Do not pretension bolts in snug-tightened joints the same as if they were in slip-critical joints. The snug-tightened condition is defined as the tightness that exists when all plies are in firm contact. This may usually be attained by a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench. If Twist-Off-Type Tension-Control Bolt Assemblies are used in snug-tightened joints, do not fully tension bolts and leave the splines intact.
   2. High-strength Bolts in Slip-critical and Pretensioned Joints:
      a. High-strength bolts in slip-critical and pretensioned joints shall be tightened to achieve the minimum bolt tension as specified in the RCSC's "Specification for Structural Joints using High-Strength Bolts" when all the fasteners of a joint are tight.
      b. Any of the four methods to tighten bolts specified in the RCSC Specification may be used to achieve the minimum bolt tension. The tightening procedure that uses direct tension indicator washers shall conform to the requirements of ASTM F 959. Conform to the requirements of ASTM F 1852 for a Twist-Off-Type Tension-Control bolt pretensioning.

E. Washers: Washers under the bolt head and/or nut shall be used as required by the RCSC Specification.

F. Bolt Lubrication: All bolts shall be well lubricated at time of installation. Dry, rusty bolts are not be allowed.

G. Impact Wrenches: Properly sized and lubricated air impact wrenches with adequate air pressure shall be utilized for all bolt installation.

H. New Bolts: All bolts shall be new and shall not be reused.

2.5 CONNECTIONS

A. Conceptual connection details with the required member design forces are shown on the drawings for bidding purposes and are applicable to all connections not designed and completely detailed on the drawings. The conceptual details are provided only to indicate the connection type required and may not fully represent the complexity of the connection as required by the final connection design for the forces they must resist. Except as noted below, the Fabricator is responsible for engaging the services of a professional engineer to prepare a final connection design for submission that meets the requirements of the conceptual connection details and resists the indicated design forces. Refer to the drawings and specifications for complete requirements.

By bidding this project, the fabricator acknowledges that additional connection elements may not be specifically shown in the conceptual details but may be required by the final connection design, such as stiffener plates, doubler plates, supplement/reinforcing plates or other connection material. The fabricator is responsible to include within his bid all material and labor required to conform to the intent of the conceptual details and to carry the design forces indicated, regardless

of whether or not all connection elements (such as stiffener plates, doubler plates, supplement/reinforcing plates or any other connection material) required by final connection design are shown in the conceptual detail.

B. Typical connection details are indicated on the drawings.

C. Design and Detailing Procedure:
   1. Unless noted otherwise or specifically detailed on the drawings, end connections of beams, girders, and trusses shall be designed as flexible and the connection shall accommodate end rotations of the unrestrained beams. Restrained end connections, as indicated on the drawings, shall be designed for the combined effect of bending moment and shears induced by the rigidity of the connection. Forces to be used in the design are described below.
   2. The Fabricator's licensed professional engineer shall design and submit sealed calculations documenting the design and showing details of the assembled joint with the bolts and welds required for the conditions noted below:
      a. For each connection not otherwise completely detailed on the drawings.
      b. Where connections are encountered on the project that do not match those assumed in the AISC Manual.
   3. Where connections are of the type than can be selected or completed using information found in tables in the AISC “Steel Construction Manual”, sealed calculations need not be submitted provided the project design conditions precisely match those assumed in the referenced publications. For conditions encountered on the project that do not conform to the AISC Manual, a complete design shall be prepared and submitted for Engineer’s review.
   4. The Fabricator’s licensed professional engineer shall seal all design calculations.
   5. The Engineer reserves the right to reject all shop drawings submitted without complete design calculations if required. Failure to adhere to the requirements of this section obligates the Contractor to take responsibility for any and all resulting delays in the detailing and fabrication of structural steel.
   6. The Fabricator, his detailer, and professional engineer shall coordinate all connection requirements with the Erector. The Fabricator is responsible to detail connections that contain the adjustability and all other requirements that allow the Erector to erect the structural steel in conformance to all specified tolerances. The Fabricator shall be responsible for providing adjustability in all connections between exterior-cladding systems, skylights, and other architectural features and the supporting structural steel as required in achieving the specified tolerances for the architectural feature as specified in the contract documents or per the manufacturer’s requirements.

D. Design Intent: It is the intention of the plans and specifications that shop connections be welded or bolted and that field connections be bolted, unless detailed otherwise on the drawings.

E. Preliminary Connection Review: Proposed variations from the details shown on the drawings will be considered and such variations must obtain preliminary approval from the Engineer prior to preparation of detailed shop drawings.

F. Flexible (Simple) Beam Connections:
   1. All typical beam simple connections shall conform to requirements of the AISC specifications. Refer to the drawings for typical connection types.
   2. Seated beam connections and stiffened seated beam connections shall not be used unless indicated on the drawings or unless Engineer approval is obtained to verify capacity of supporting member for the resulting eccentricity. The Fabricator must verify and bear responsibility that the use of such connections does not interfere with architectural or MEP requirements.

3. Simple Beam Connection Capacity: Support a factored load reaction R equal to the reaction shown on the plans. Contact the Engineer if no reaction for a beam is shown on the plan. Each connection shall contain not less than the minimum number of bolts shown in the AISC connection tables for each beam size.

G. Restrained (Moment) Connections:
1. Refer to the drawings for moment connection details.
2. Design Reactions for Moment Connected Beams: Shear connections for moment-connected beams shall be designed for the factored reactions shown on the drawings.
3. Design and Furnishing of Reinforcement in Moment Connected Joints: As part of the design responsibility outlined above, the fabricator shall design and furnish all additional reinforcement in moment connected joints to resist the specified design forces unless otherwise specifically detailed on the drawings. Column sections shall be investigated for web shear, web yielding, web buckling, and tension. Stiffeners and/or doubler plates shall be furnished as required by the AISC Specification Section J10.

H. Tightening of Bolts in Welded Moment Connections: At moment connections where beams are complete-joint penetration welded directly to columns or girders in the field, welds shall be made after installation of erection bolts to draw the pieces together and before the final shear connection bolts are tightened. Where loose moment plates are used, such plates shall be groove welded to columns prior to connecting these plates to the beams.

I. Column Splices:
1. Compression Splice: Unless indicated otherwise on the drawings, all column splices shall be either a bolted compression splice using high strength snug-tightened bolts or a welded compression splice. Splice and filler plate sizes, thicknesses, and number of fasteners or weld information shall be as shown in Table 14-3 of AISC "Steel Construction Manual". It shall be the Fabricator's responsibility to examine the architectural drawings to verify that splice plates and fasteners do not violate architectural finish requirements.
2. Bearing and Fit-Up of Column Compression Joints: All column splices, except those that are direct welded with complete-joint penetration welds, shall be considered as a compression joint as defined herein unless noted otherwise on the drawings.

J. Base Plates and Bearing Plates:
1. Finish: All baseplates and bearing plates shall be finished in accordance with AISC Specification M2.8.
2. Anchor Rod Holes in Baseplates: Hole sizes in baseplates for anchor rods shall be per the AISC "Steel Construction Manual", Table 14-2.

K. Trusses:
1. Truss Geometry: Chord and web lines shown on truss elevations represent the centroid of the truss member unless detailed otherwise.
2. Design Forces: Truss connections shall be designed for the forces indicated on the drawings, but not less than 30 percent of the effective tensile strength of the member except in cases where there is only a compression force noted. In that case the connection design force shall be not less than 50 percent of the effective compression strength of the member.
3. Member End Supplement Plates: Tension members in bolted trusses have been proportioned based on yielding in the gross section. Therefore, connections removing more than (1-(.9Fy/.75Fu)) of the gross member area at any cross section shall have steel plates welded to the member cross section and extended along the member length to develop the tensile strength of the plate in order to replace material removed so that the member does not fail by fracture of the net section. The responsibility for the design and furnishing of these plates shall rest with the Fabricator.

L. Hangers and Braces:
   1. Connections for all hangers and braces shall have connections designed to develop the factored axial force shown on the drawings. Contact the Engineer if no force for a member is shown on the drawings.
   2. Compression members composed of two or more rolled shapes separated from one another by intermittent fillers shall be connected to one another at such fillers at intervals (not to exceed 48”) so that the slenderness ratio l/r of either shape, between the fasteners, does not exceed 75% of the governing slenderness ratio of the built-up member. The least radius of gyration, r, shall be used in computing the slenderness ratio of each component part.

M. Stiffeners: Provide stiffeners finished to bear under load concentrations where shown on the drawings.

N. Steel Shelf Angles: Shelf angles supporting veneer shown on the drawings to be continuous shall be furnished to a maximum length of 20’-0”. Provide a 1/4" gap at each joint. The gap shall not be welded. The distance from the joint to the first supporting bolt shall not exceed 40% of the bolt spacing (12" maximum). Shelf angles shall be continuous around corners with corner joint complete-joint penetration welded. The distance to the first supporting bolt from the corner shall not exceed 12”.

O. Limitations on Use of A307 Bolts: ASTM A 307 bolts shall not be used in any permanent steel-to-steel or concrete-to-steel connection.

P. Bolts in Combination with Welds: Bolts shall not be considered as sharing the load in combination with welds, except as allowed in AISC Specification Section J1.8.

2.6 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. Specification: Surface preparation, paint, and painting practices shall conform to the "SSPC Painting Manual", Volumes 1 and 2.

B. Scope: All steel shall remain unpainted, except the following:
   1. Shop paint surfaces that are to remain exposed to view in the final construction.
   2. Shop paint any steel other than weathering steel that, in the final construction, will not be in a controlled environment and is therefore subject to moisture or high humidity infiltration and that has not been specified to be galvanized.
   3. Shop paint any steel that is shown on the drawings to receive a finished paint system as defined in Specification 099600.
   4. Coordinate all shop painting of structural steel with Architect's painting requirements as specified on the architectural drawings and in the specifications. The Fabricator shall be responsible for determining all painting requirements (which surfaces are to be painted or left unpainted) on the project prior to fabrication.

C. Additional Painting Requirements:
   1. Extend shop paint to 2" from location of welds on surfaces that are to be field welded.
   2. All unpainted mating surfaces of all elements that are welded together into an assembly that is permanently exposed to the exterior shall be seal welded in addition to structural welding requirements.
   3. If individual elements (including the mating surfaces) of an assembly that is required to be painted are painted prior to welding into an assembly, then all painted surfaces affected by welding shall be touched-up and repaired (according to manufacturer’s instructions, if any) to prevent corrosion bleeding.

4. The fabricator shall be responsible to ensure that all elements of all assemblies that are to be painted are fabricated so that no exposed surface shall be subject to stains due to corrosion bleeding during the warranty period of the paint.
5. Structural steel elements that are bolted with slip-critical joints and are required on the drawings to be painted shall have all faying surfaces (including all surfaces of filler plates, member end supplement plates, and welds) painted to comply with the specified slip-critical coating requirement.

D. Surface Preparation – Unpainted Steel: All structural steel that is not specified to receive a shop coat of primer paint shall be prepared in accordance with Society for Protective Coatings specifications as follows:
1. SSPC-SP 2, “Hand Tool Cleaning” or SSPC-SP 3, “Power Tool Cleaning” unless otherwise specified.
2. SSPC-SP 6, “Commercial Blast Cleaning” shall be applied to the faying surfaces of connections that are noted on the drawings as slip-critical connections requiring a Class B surface. Apply this surface preparation to the area surrounding all bolt holes including the area up to 2” outside the outer-most holes.

E. Surface Preparation and Primer Paint – Shop Painted Steel:
1. Surface Preparation: Prepare the surface of all structural steel specified to be shop painted as required by the paint manufacturer or the Society for Protective Coatings specifications, but not less than the following:
   a. SSPC-SP 2, “Hand Tool Cleaning” or SSPC-SP 3, “Power Tool Cleaning” unless otherwise specified.
   b. SSPC-SP 6, “Commercial Blast Cleaning” shall be applied to the faying surfaces (including filler and member-end supplement plates, if any) of connections that are noted on the drawings as requiring a slip-critical coating. At a minimum, apply this surface preparation to the area between and surrounding all bolt holes including the area up to 2” outside the outer-most holes.
2. Priming: Immediately after surface preparation, apply primer to all structural steel specified to be shop primed in strict accordance with manufacturer’s instructions and the Society for Protective Coatings specifications. Apply paint at a rate to conform to the manufacturer’s written instructions and to provide a dry film thickness of not less the 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, welds, and all exposed surfaces. Apply two coats to surfaces that are inaccessible after assembly or erection. Change the color of the second coat to distinguish it from the first coat.
3. Finish Coat: Coordinate shop primer paint requirements with architectural drawings and specifications. The primer selected must be compatible with any specified finish coat.

F. Shop Touch-Up Painting: The Fabricator shall provide for cleaning and touch-up painting of welds, bolted connections (including nuts, bolts, washers, filler plates, member end supplement plates and welds, if any), and abraded areas. Prior to shipment, apply paint to exposed areas using same materials and surface preparation as used for shop painting. Paint shall be applied by brush or spray with minimum dry film thickness of 1.5 mils.

2.7 SOURCE QUALITY CONTROL

A. Source Testing and Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with structural steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection Prior to Erection: Erector shall examine areas and conditions under which structural steel work is to be installed and notify the Contractor and the Architect/Engineer in writing of conditions detrimental to proper and timely completion of the work.

3.2 PREPARATION

A. Temporary Shoring and Bracing:
   1. The lateral-load resisting or stability-providing system and connecting diaphragms are identified on the drawings. Comply with the provisions of the Code of Standard Practice regarding stability of the structure during the erection process, except where stricter requirements are noted herein.
   2. The Erector shall design and provide all required temporary shoring and bracing to hold structural framing securely in position and to safely withstand all loads as specified in the Code of Standard Practice and ASCE 37 unless larger loads are required by the local building code or specified herein. Provide all bracing, any additional structural members, and increase member sizes and/or connections shown on the drawings as required to accommodate the erection loads, methods, sequence of erection, and equipment until the lateral-load resisting or stability-providing system is completely installed. Clearly show all temporary supports and modifications to designed members on the Shop Drawings and the Erection-bracing Drawings. A qualified licensed professional engineer, hired by the Erector, shall design the temporary shoring and bracing and shall seal the erection-bracing drawings.
   3. Where architectural or MEP requirements do not allow for any temporary supports, members, erection devices, or connections to be left in place permanently or where such items affect the final structural behavior, they shall be removed by the Erector. All costs associated therewith shall be included in the bid price.

B. High-Strength Bolt Testing:
   1. The Erector shall perform the following tests for high-strength bolts:
      a. The Rotational Capacity Test shall be performed on the following combinations of fastener assembly lots prior to use in the project.
         1) All bolts in long-span trusses.
         2) All ASTM A 490 bolts 1-1/4” diameter and larger.
         3) All ASTM A 490 bolts when coated with Dacromet or other protective coating.
      b. The Rotational Capacity Test shall be performed in accordance with ASTM F 3125-15 Annex A2and with the following sampling rate:
         1) Test all black or galvanized bolt, nut, and washer assemblies.
         2) Test each combination of bolt production lot, nut lot, and washer lot as an assembly and assign a lot number to each lot tested.
         3) Test two samples from each assigned assembly lot.
      c. Results of each Rotational Capacity Test shall be submitted to the Testing Laboratory for review.
   2. The Testing Laboratory shall perform the following tests for connections joined with high-strength bolts:
      a. Perform Arbitration Testing according to procedures outlined in the "Specification for Structural Joints using High-Strength Bolts" when a disagreement exists between the Testing Laboratory and the Fabricator as to the minimum tension of installed bolts that have been inspected according to paragraph below.

3.3 ERECTION

A. The erection work shall comply with the requirements of AISC Specification Section M4.

B. Surveys: The following surveys shall be performed by a qualified land surveyor:
   1. Initial Survey: Check elevations of concrete and masonry bearing surfaces, anchor bolt locations, embedded connection plates, and all dimensions of existing structures to which new connections are to be made prior to erection and submit any discrepancies to the Engineer prior to the start of erection. Corrections or compensating adjustments to the structural steel shall be made and approved prior to the start of erection.
   2. Final Survey: Upon completion of erection of the steel frame, and before the start of work by other trades that may be supported, attached, or applied to the frame, a final survey shall be made and a report submitted certifying compliance with specified tolerances.

C. Erection Tolerances: Erection tolerances of anchor rods, embedded items, and all structural steel shall conform to the AISC Code of Standard Practice, Section 7, unless stricter tolerances are specified elsewhere in the contract documents.
   1. Erection of Long-span Steel:
      a. A detailed written erection procedure that has been reviewed and approved by the Erector and the General Contractor shall be submitted for review and approval by the Engineer.
      b. Design, provide all material for, and construct all erection towers as required to erect the long-span steel system.
      c. An alternate erection procedure may be proposed by the contractor as a substitution under the Division 01 specifications. The contractor shall hire a registered professional engineer to do a complete structural analysis of the long-span system to ensure strength and stability requirements are met during all stages of the erection. Calculations prepared under the supervision of the registered professional engineer showing the size and stability checks of the long-span system shall be submitted for review and approval by the Engineer-of-Record. Detailed shop drawings prepared under the supervision of the registered professional engineer of all necessary hardware and any reinforcing of the long-span system shall be submitted for review by the Engineer.

D. Wherever the erection equipment is supported by the structure, the contractor shall be responsible for the retention of a licensed professional engineer to determine the adequacy of the member supporting the erection equipment in relation to the loads imposed thereon. The Contractor shall submit to the Architect/Engineer, for review, the loads that will be imposed by the erection equipment on the building structure. Where the imposed load exceeds the allowable strength, the Contractor shall be responsible for any additional materials, supports, bracing, connections and similar measures required to support the imposed load of the equipment while in use, subject to review by the Architect/Engineer.

E. Anchor Rods: Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout. Use only steel wedges or shims.

F. Base Plates and Bearing Plates: Remove loose latent material from bearing surfaces and base and bearing plates. Set plates to the elevation indicated on the drawings and level using steel shims (plastic shims will not be allowed) or by three leveling screws with weldments at the plate edges. After all protruding plates have been trimmed, grout plates solidly between bearing surfaces using the specified grout, ensuring no voids are present. Finish exposed surfaces, protect installed materials, and allow to wet cure. For proprietary grout materials, comply with

manufacturer's instructions. Tighten anchor bolts after supported members have been positioned and plumbed.

G. Splices: Splices will be permitted only where indicated on the contract drawings and approved shop drawings. Fastenings of splices of compression members shall be done after the abutting surfaces have been brought completely into contact within AISC tolerances. Bearing surfaces and surfaces that will be in permanent contact are to be cleaned before the members are assembled.

H. Field Assembly of Structural Steel:
1. As erection of the steel progresses, the work shall be fastened securely to safely carry all dead load, wind, and erection forces. Particular care shall be exercised to ensure straightness and tautness of bracing immediately upon raising a steel column.
2. Provide temporary planking and working platforms as necessary to effectively complete work.
3. Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of structure within specified AISC tolerances. The Contractor shall coordinate with Erector and Fabricator regarding possible discrepancies in member lengths between temperature at time of fabrication and temperatures during erection, and shall make necessary adjustments to ensure plumbness within AISC tolerances at 70°F. Compensate for cumulative welding draw, construction loadings, sequential applications of dead loads, or any other predictable conditions that could cause distortions to exceed tolerance limitations.
4. On welded construction exposed to view or weather, remove erection bolts, fill holes with plug welds or filler and grind smooth at exposed surfaces.
5. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces receiving field welds.
6. Comply with all bolting and welding requirements of Part 2 of this specification.

I. Field Modifications to Structural Steel: Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and structural fitting of parts shall be reported immediately to the Architect/Engineer, and approval of the method of correction shall be obtained. Approved corrections shall be made at no additional cost to the Owner. Do not use cutting torches, reamers, or other devices in the field for unauthorized correction of fabrication errors.

J. Miscellaneous Framing: Provide supplemental structural steel support framing for steel deck where columns, or other framing members or floor openings interrupt normal deck bearing whether shown or not on the architectural, mechanical, or structural drawings.

K. Removal of Erection Aids and Devices: The Erector shall remove all erection aids and devices that interfere with architectural finish or MEP requirements.

L. Field Touch-Up Painting:
1. Clean field welds, unpainted areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any shop painted areas that are abraded. Apply paint to all exposed areas using same material and surface preparation as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.
2. Clean field welds, ungalvanized areas of bolted connections (including all exposed areas of nuts, bolts, washers, filler plates, member end supplement plates, and welds), and any

galvanized areas that are abraded. Prepare surfaces and apply two coats of the specified galvanizing repair paint in accordance with ASTM A 780.

3. The Contractor shall ensure that, at the substantial completion of the project, all structural steel, bolted and/or welded, required to be painted shall have all necessary steel surfaces painted (including touch-up painting as required) to prevent corrosion bleeding.

M. Shear Connector Installation:
   1. Composite Beams:
      a. Studs shall be welded in the field (not the shop) using automatically timed stud welding equipment.
      b. The top flange of the beams must be unpainted and free of heavy rust, mill scale, dirt, sand or other foreign material which will interfere with the welding operation.
      c. The steel deck must be free of dirt, sand, oil, or other foreign material and must be dry and free of moisture. Steel deck must rest tightly on the beam flange. Welding must take place through only one thickness of deck.
      d. Stud Spacing: Studs shall be spaced on beams and girders as shown on the drawings.

N. Headed Stud Anchor Installation:
   1. Steel Plates Embedded in Concrete:
      a. Studs shall be welded using automatically timed stud welding equipment.
      b. Plates must be unpainted and free of heavy rust, mill scale, dirt, sand or other foreign material that will interfere with the welding operation.

O. Clean Up: Clean up all debris caused by the Work of this Section, keeping the premises neat and clean at all times.

3.4 FIELD QUALITY CONTROL

A. Field Testing and Inspection: Refer to Specification 014529 “Structural Testing and Inspections” for testing and inspection requirements associated with structural steel.

END OF SECTION 051200

SECTION 053100 – STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. Section includes all labor, materials, services, equipment, and hardware required in conjunction with or related to all steel deck work, including but not necessarily limited to deck units, cover plates, pour stops, hanger slots or clips, steel deck edge closures, cell closures, and all related accessories.

B. Related Requirements:
1. Specification 014000 “Quality Requirements” for requirements of material testing and inspection.
2. Specification 014529 “Structural Testing and Inspections”
3. Specification 032000 “Concrete Reinforcing” for reinforcement in steel deck slabs.
4. Specification 033000 “Cast-in-Place Concrete” for normal-weight and lightweight structural concrete fill over steel deck.

1.3 REFERENCES

A. Definitions:
1. Professional Engineer: A professional engineer who is licensed to practice engineering in the state where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with steel decking that are similar to that indicated for this Project in material.

B. Reference Standards:
1. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified.
   a. AISI, “Specification for the Design of Cold Formed Steel Structural Members.”
   b. AWS D1.3, “Structural Welding Code - Sheet Steel.”
   c. SDI, “Design Manual for Composite Decks, Form Decks, and Roof Decks.”

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Quality Control: The Contractor is responsible for quality control, including workmanship and materials furnished by subcontractors and suppliers.
2. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings

and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

3. Materials and installed work may require testing and retesting, as directed by the governing building code or the Architect/Engineer, at any time during progress of work.
   a. The Contractor shall provide adequate notification to the Owner's Testing Agency of construction operations including the project schedule to allow the Testing Agency to schedule inspections. Failure to notify sufficiently may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.
   b. The Contractor shall cooperate with laboratory personnel, provide access to the work, and provide access to manufacturer's operations.
   c. The Contractor shall make adequate arrangement with the Owner's Testing Agency for inspection of material stockpiles and facilities.
   d. The Contractor shall provide to the laboratory certificates and representative samples of materials proposed for use in the work in quantities sufficient for accurate testing as specified.
   e. The Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate the required inspections and tests.
   f. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Tests not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See 014529 Structural Testing and Inspections section of the Specifications.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of deck specified.

B. Shop Drawings: Submit detailed shop drawings showing type of deck, complete layout, attachment details, closures, edge strips, pans, deck openings, special jointing, supplementary framing, and all other accessories.

C. Certificates: Submit a certificate of product compliance with SDI standards as specified.

D. Delegated Design Submittals: If the submitted deck does not comply with the minimum properties shown on the drawings, the steel deck manufacturer shall submit design calculations sealed by a Professional Engineer verifying compliance with the specifications for all load and span conditions shown on the drawings.

E. Qualification Statements:
   1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in the "Qualifications" section under Part 1. If recertification of welders is required, retesting will be at Contractor's responsibility.

F. Insurance Certification: Assist Architect and Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire, windstorm, and extended coverage insurance.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Supplier: The steel deck supplier shall be a manufacturer with a minimum of two years of successful experience and with a minimum of two successful projects of a comparable size and scope to this project.
   2. Erector: The steel deck erector shall have a minimum of two years of successful experience and with a minimum of two successful projects of a comparable size and scope to this project.
   3. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS D1.3 procedures.

B. Underwriters Laboratories Classifications:
   1. Provide steel deck units which are listed and conform to Underwriters Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific fire-resistant system detailed.
   2. Provide units and construction meeting the requirements of Construction No. [**58**] [**76**] [**157]** [**192**] [**234**] [**241**] [**266**] [**110**] [**143**] [**155**] [**250**] [**434**] as listed in the 2006 UL “Roofing Materials & Systems Directory” under Roof Deck Constructions (TGKX) and rated as a Class [**30**] [**60**] [**90**] assembly, and with each deck unit bearing the UL label and marking for specific wind-rated system detailed.

PART 2 - PRODUCTS

2.1 COMPOSITE FLOOR DECK

A. General Requirements
   1. See the drawings for location of steel deck types and for depth of deck, design deck properties, design deck yield strength, concrete type, total slab thickness, slab reinforcing, and design superimposed loads. The average rib width to depth of deck ratio shall be greater than or equal to 2.0. The deck properties specified are the values used for the design of the deck shown on the drawings. Provide deck with the depth as noted and other properties equal to or greater than the values stated on the drawings except that a deck with properties less than those stated, other than depth, may be used provided that the deck manufacturer take responsibility for the design of the deck. The design shall include the ability to carry the construction dead loads and design superimposed loads indicated for all the spans shown on the drawings and to meet all performance criteria as specified by the SDI. Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with “SDI Specifications and Commentary for Composite Steel Floor Deck”.
   2. Acceptable manufacturers include the following:
      a. ASC Steel Deck.
      b. Canam Steel Corp.
      c. New Millennium Building Systems, Inc
      d. Cordeck.
      e. DACS, Inc.
      f. Marlyn Steel Decks, Inc.
      g. New Millennium Building Systems, Inc.
      h. Roof Deck, Inc.
      i. United Steel Deck, Inc.
      j. Valley Joist, Inc.
      k. Verco Manufacturing Co.

l. Vulcraft/Div. Nucor Corp.
m. Other manufacturers may be used only with Architect/Engineer approval.

B. Grade of Steel:
1. Composite steel deck shall be cold formed from steel sheets conforming to ASTM A1008 or ASTM A653, Structural Steel Grade, with a minimum yield strength as stated on the drawings. The delivered thickness of the uncoated steel shall not be less than 95% of design thickness. Sheet metal accessories shall conform to the same material specification as the deck product.

C. Finish:
1. Galvanized: Composite steel deck shall be galvanized with a protective zinc coating conforming to ASTM A653 G90.
2. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Department of Defense Specifications DOD-P-21035.

D. Fabrication:
1. Steel Deck Spans: The deck properties shown on the drawings are selected so that the spans do not exceed the maximum clear spans with unshored construction as required by SDI criteria unless indicated otherwise on the drawings. The deck manufacturer shall be responsible for supplying a deck that meets that criterion. Where possible, all steel deck shall extend over three or more spans. Simple span deck will not be permitted unless it is shored at midspan or approved by EOR. Any additional concrete topping specified over the composite slab shall be placed after the slab has reached 75% of its design strength.

2.2 ROOF DECK

A. General Requirements:
1. See General Notes on the drawings for the location, depth of deck, design thickness, and type of deck required.
2. Acceptable manufacturers include:
a. ASC Steel Deck.
b. Canam Group.
c. New Millennium Building Systems, Inc
d. Cordeck.
e. Epic Metals Corp.
f. Loadmasters Systems, Inc.
g. Marlyn Steel Decks, Inc.
h. New Millennium Building Systems, Inc.
i. United Steel Deck, Inc.
j. Valley Joist, Inc.
k. Verco Manufacturing Co.
l. Vulcraft/Div. Nucor Corp.
m. Other manufacturers may be used only with Architect/Engineer approval.

B. Grades of Steel:
1. Steel deck shall be manufactured from steel conforming to ASTM A1008 Grades C, D, or E for painted deck or A653, Structural Steel Grade for galvanized deck or Engineer approved equal, having a minimum yield strength as stated on the drawings.

C. Finish:
1. Galvanizing: Steel deck shall be galvanized with a protective zinc coating conforming to ASTM A653 G90.

2. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with Department of Defense Specifications DOD-P-21035.

D. Fabrication:
1. General: Fabricate deck panels, without top-flange stiffening grooves, to comply with “SDI Specifications and Commentary for Steel Roof Deck”, in SDI Publication No. 29, and the following.
2. Steel Deck Spans: Where possible, all steel deck shall extend over three or more supports. Single span deck is prohibited.

2.3 ACCESSORIES

A. Mechanical Fasteners:
1. Powder-Actuated or Pneumatically Driven Pins: Provide corrosion-resistant, powder-actuated or pneumatically driven fasteners manufactured from steel conforming to AISI 1060 or 1061 steel, austempered to a core hardness of 52 to 58 Rockwell C. Fasteners shall have a knurled shank and shall be zinc-plated in accordance with ASTM B633, Sc. I, Type III.
   a. Subject to compliance with requirements, provide products of one of the following manufacturers:
      1) Hilti, Inc.
      2) ITWBuildex.
      3) Pneutek, Inc.
2. Self-Drilling Screw Fasteners: Provide corrosion-resistant, hexagonal head, steel self drilling screws, austempered to a core hardness of Rockwell C 50.
   a. Subject to compliance with requirements, provide products of one of the following manufacturers:
      1) Hilti, Inc.
      2) ITWBuildex.
      3) Grabber Construction Products.
      4) SFS Intec Fastening Systems, Inc.
      5) Textron Fastening Systems.

B. Side-Lap Fasteners:
1. Provide corrosion-resistant, hexagonal washer head undercut with reverse serrations, self-drilling, carbon-steel screws, No. 10 minimum diameter.
   a. Subject to compliance with requirements, provide products of one of the following manufacturers:
      1) Hilti, Inc.
      2) Other approved alternative.

C. Roof Deck Accessories:
1. Provide minimum 20 gauge ridge and valley plates, minimum 20 gauge cant strips, minimum 14 gauge sump pans, minimum 20 gauge inside or outside closure channels angles or plates, minimum 20 gauge butt strips at change of deck directions, and minimum 20 gauge filler sheets.
2. Provide a 20 gage galvanized flat plate to reinforce openings in roof deck that are greater than 6” and less than 10” in any one direction.

D. Composite/Form Deck Accessories:
1. Flexible Closure Strips: Provide manufacturers standard vulcanized closed cell, synthetic rubber.
2. Acoustic Sound Barrier Closures: Provide manufacturers standard mineral fiber closures.

3. Metal Cover Plates – Cellular Deck: Fabricate metal cover plates for end abutting floor deck units of not less than same thickness as decking, formed to match contour of deck units.
4. Cell Closure at Ends of Steel deck Flutes: Fabricate metal closure strips of not less than 0.0358" minimum (20 gage) cold formed sheet steel. Form to provide tight fitting cell closures at open ends of cells or flutes to prevent wet concrete from leaking through open cells.
5. Pour Stop Closures at Slab Edges: Provide sheet metal pour stop closures at all slab edges, columns, walls, and openings unless steel angles or bent plates are specified in details on the drawings. The closures shall be fabricated from light gage steel not less than the thickness shown below when the slab edge is parallel to the deck span. Provide a return lip on the vertical leg in accordance with the SDI Design Manual. The overhang dimension is measured from the edge of the flange to the edge of the slab.
   a. Slab thickness = 7.5”
      1) Overhang between 0” and 4”: 12 gage.
      2) Overhang between 4” and 8”: 10 gage.
      3) Overhang greater than 8”: Not acceptable as light gage.

E. Openings on Concrete Floor:
   1. For unframed openings, provide blockout in slab for opening with deck uncut. Cut deck at opening after concrete has been poured and obtained 75% of its design strength. See Section 032000, “Concrete Reinforcing”, for reinforcing in the slab around all unframed openings in steel deck that are greater than 10” width in either direction.

F. Extra Concrete Required for Deck Deflection
   1. The General Contractor shall include in his bid additional concrete required for steel deck slabs to account for deck deflection.

2.4 CONCRETE SLAB REINFORCEMENT

A. See drawings for reinforcement in composite and non-composite concrete slabs. See Section 033000, “Cast-in-Place Concrete”, for minimum reinforcement requirements.

2.5 CHLORIDE ADMIXTURES

A. The use of admixtures in concrete containing chloride salts shall not be permitted for steel deck concrete.

2.6 ROOF OPENINGS

A. Provide a 20 gage galvanized flat plate to reinforce openings in roof deck that are greater than 6” and less than 10” in any one direction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install deck units as accessories in accordance with manufacturers recommendations and approved shop drawings, and as specified herein:
   1. Place deck units on supporting framework and adjust to final position with ends accurately aligned and minimum bearing on supporting members indicated below before being permanently fastened. Do not stretch or contract side lap interlocks. Place the end joint over a chord angle for deck bearing on steel joists.
   2. Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.
   3. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
   4. Do not place deck units on concrete supporting structure until concrete has cured and is dry.
   5. Do not use floor or roof deck units for storage or working platforms until permanently secured.
   6. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
   7. The Contractor is responsible for temporary deck fastening to meet OSHA requirements to use the floor deck unit as a storage or working platform before final attachment is installed.

B. Deck Attachments: The deck shall be fastened to the structural support members using one of the following methods:
   1. Powder-Actuated Driven Pins:
      a. An operator licensed by the manufacturer shall install all pins.
      b. Comply with the manufacturer’s requirements to install the pins through all layers of the deck material and the manufacturer’s required embedment into the supporting member.
   2. Welding: Welds shall be puddle welds with diameters as indicated below. Where two deck units abut each other, each unit shall be so welded. Puddle welds may be replaced with welded shear connectors when applicable.
      a. All welding shall be performed by AWS qualified welders unless otherwise approved by the building official.
      b. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.
      c. Weld metal shall penetrate all layers of deck material at end laps and side joints and shall have good fusion to the supporting member.
      d. Welding washers shall be used only when welding steel deck less than 0.028" thickness. Welding washers shall be a minimum thickness of 0.0568 inches and have a nominal 3/8" diameter hole.
   3. Self-Drilling Fasteners: Comply with the manufacturer's requirements to install the screws through all layers of the deck material and the manufacturer's required embedment into the supporting member.
   4. Attachment of Composite Deck:
      a. Powder-Actuated Driven Pins: Refer to the drawings for type of pin used and number and spacing of attachments.
      b. Welding: Steel deck units shall be welded to the structural support members with 5/8" diameter puddle welds at each end of sheet and each intermediate support at each low flute, unless more frequent attachment is specified on the drawings.

1) Welding Washers: Welding washers shall be used when welding steel deck units less than 0.028" thickness.

c. Self-Drilling Fasteners may not be used for attachment of composite deck.

d. Attachment to Girders: Steel deck units shall be attached to girders (steel framing that is parallel to span of deck) using one of the specified fastening methods at a spacing of 12" center to center.

e. Side Laps: Unless noted otherwise on the drawings, side laps of adjacent units shall be fastened by welding (1-1/2 inch long), sheet metal screws (No. 10 or larger) or button punching at maximum intervals not exceeding the lesser of half of the span or 36".

f. Welding of Composite Deck used on Roof: In addition to the minimum attachment specified above, typical areas of the roof deck shall be welded to resist the net uplift pressures as specified in the General Notes on the drawings

g. Minimum Bearing: Provide a minimum deck bearing of 1 1/2" over all supports with butted end joints.

h. Cellular Decks: Keep the interiors of cells that will be used as raceways free of welds or screw edges having sharp points or edges.

5. Attachment of Roof Deck:

a. The method of attachment, attachment pattern, and side lap fastener type and spacing, shall be as shown on the drawings and comply with the requirements noted below.

b. Powder-Actuated or Pneumatically Driven Pins.

c. Welding: Use 5/8” diameter puddle welds.

d. Self-Drilling Fasteners.

e. Side Lap Fastening: Unless required otherwise by provisions of Factory Mutual, Underwriters Laboratories, or this specification, side laps of adjacent units shall be fastened by welding (on 20 gauge or heavier deck only) or #10 (minimum) TEK screws so that spacing between supports and fasteners does not exceed the value prescribed on the drawings. Nest side laps one-half corrugation for form deck. Button punching is not allowable as a side-lap fastener.

f. End Bearing: Provide a minimum end bearing of 2" over supports.

g. End Joints: End joints of sheets shall be lapped 2” minimum over supports unless a more stringent requirement is specified by Factory Mutual or Underwriters Laboratory. Decks that slope 1/4 inch or more in 12 inches in the long direction shall be erected beginning at the low side to insure that end laps are shingle fashion.

h. Underwriters Laboratories Wind Uplift Classification Requirements: Unless a more stringent attachment requirement is specified elsewhere in this specification or on the drawings, roof deck units shall be attached to the supporting structure as required by the Construction Number specified elsewhere in this section.

i. Attachment to Girders: At locations noted in the drawings, attach the deck to steel members that are parallel to the deck flutes in accordance with the requirements noted in the drawings.

j. Definition of Perimeter and Corner

1) Definition of Roof Height: Roof height shall be defined as eave height for roofs that slope less than 10% and mean roof height for roofs with a greater slope.

2) Buildings with roof heights of 60 feet or less

a) Perimeter: The width of the perimeter strip shall be the smaller of one-tenth the least building dimension and four-tenths the roof height but not less than 4 feet. The strip either side of a ridgeline shall be considered as a perimeter strip for the purposes of deck fastening for roofs that slope between 10° and 45°.

b) Corner: On an exterior (not re-entrant) corner, a strip the width of a perimeter strip defined above and extending for a length equal to the

dimension of one perimeter strip each direction from the exterior corner.

3) Buildings with roof heights greater than 60 feet
   a) Perimeter: The width of the perimeter strip shall be one-tenth the least dimension of the building but not less than four feet.
   b) Corner: On an exterior (not re-entrant) corner, a strip the width of a perimeter strip defined above and extending for a length equal to the dimension of two perimeter strips each direction from the exterior corner.

k. Underwriters Laboratories Wind Uplift Classification Requirements: Unless a more stringent attachment requirement is specified elsewhere in this specification or on the drawings, roof deck units shall be attached to the supporting structure as required by Construction Number specified elsewhere in this section.

l. Attachment to Girders: At locations where the deck flutes are parallel to the span of the steel framing and the top of the framing is at the bottom of the deck elevation, the deck shall be attached to the girder using one of the specified fastening methods at 18 inches on center.

C. Welding Requirements: Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

D. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking.

E. Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work.
   1. Roof Openings: Roof openings less than 6” square or diameter require no reinforcement. Opening 6” to 10” inclusive shall be reinforced with a 20 gauge galvanized plate welded to the deck at each corner and 6” maximum centers with a 5/8” diameter puddle weld or sheet metal screws. For openings greater than 10” in diameter or width, refer to the drawings and structural steel specifications for additional framing to support the deck around the opening.

F. Hanger Slab or Clips: Provide UL approved punched hanger slots between cells or flutes of lower element where floor deck units are to receive hangers for support of ceiling construction, air ducts, diffusers or lighting fixtures.
   1. Hanger clips designed to clip over male side lap joints of floor deck units may be used instead of hanger slots.
   2. Locate slots or clips at not more than 14" o.c. in both directions, not over 9" from walls at ends, and not more than 12" from walls at sides, unless otherwise shown.
   3. Provide manufacturer's standard hanger attachment devices.
   4. Loads hanging from steel deck slabs shall not exceed 100 pounds unless specifically detailed otherwise on the drawings.

G. Joint Covers and Cell Closures: Weld steel sheet joint covers at abutting ends and at changes in direction of deck units, except where taped joints are specified. Weld steel sheet column closures, cell closures and Z-closures to deck with 1" long weld at 12" maximum centers to provide tight-fitting closures at open ends of ribs, unless shown otherwise on the drawings.

H. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated. Provide minimum 2" bearing over steel support.

I. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld in each corner.

J. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

3.2 TOUCH-UP PAINTING

A. After deck installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members.

B. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

C. Touch-up painted surfaces with same type of shop paint used on adjacent surfaces.

D. In areas where shop-painted surfaces are to be exposed, apply touch-up paint to blend into adjacent surfaces.

3.3 FIELD QUALITY CONTROL

A. Field Testing and Inspection: Refer to Specification 014529 "Structural Testing and Inspections" for testing and inspection requirements associated with steel decking.

END OF SECTION 053100

SECTION 054000 – COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Extent of cold-formed metal framing used as structural support for exterior cladding and/or used as loadbearing support for any floor or roof areas is shown on the drawings.

B. Types of cold-formed metal framing units include the following exterior non-load bearing stud framing supporting cladding.

1.3 QUALITY ASSURANCE

A. AISI, “North American Specification for the Design of Cold-Formed Steel Structural Members."

B. AISI, “Standard for Cold-Formed Steel Framing – General Provisions.”

C. AWS D1.1, “Structural Welding Code – Steel.

D. AWS D1.3, "Structural Welding Code - Sheet Steel.

E. Professional Engineer Qualification: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this project in material, design and extent.

F. Product Certification: Manufacturer’s material certification or data from an independent testing agency that is qualified according to ASTM E 329 indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness

G. Fire-Rated Assemblies: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product information, certification, and installation instructions for each type of cold-formed metal framing and accessory indicated. Include test reports and published allowable loads for all fasteners used.

B. Shop Drawings: Submit shop drawings for all cold-formed metal framing used to support exterior cladding, floor or roof framing, ceiling or soffit framing and load-bearing support framing for any floor or roof areas. Shop drawings shall indicate placing of all framing members showing type, size, member thickness, number, location and spacing. They shall also indicate supplemental strapping, bracing, splices, bridging, accessories and details required for proper installation. Shop drawings must indicate type of fastening system used along with size and number of fasteners.

1. Welded connections shall show size and length of welds for all connections.

2. Screwed connections shall show type, size, and number of screws for all connections. Submit manufacturer's data giving strength values for screws used.

3. Connections using anchors shall show product name, embedment, edge distance and spacing.

4. Shop drawings submitted must be prepared under the supervision of and sealed by a professional engineer licensed in the state where the project is located.

C. Calculations: Submit calculations for all cold-formed metal that are prepared and sealed by a professional engineer licensed in the state where the project is located. Calculations shall indicate sizing of members supporting the loads as indicated on the drawings and the design of connections indicating method of connection and

1. Size and length of all welds for welded connections.

2. Type, size, number and capacity of all screwed connections.

D. Deflection Limits: Design framing to withstand loads without deflections greater than the following:

1. Back-up for flexible materials: L/240

E. Welding certificates.

F. Qualification data for professional engineer.

1.5 DELIVERY AND STORAGE

A. Protect metal framing units from corrosion, deformation, and other damage during delivery storage and handling.

B. Deliver to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type and grade.

C. Store off ground in a dry ventilated space or protect with suitable waterproof coverings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing shall be members of the Steel Stud Manufacturer's Association unless otherwise agreed to by the Engineer.

2.2 SYSTEM COMPONENTS

A. With each type of metal framing indicated on the Architectural or Structural Drawings, provide manufacturer's standard steel studs, joists, rafters, runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners and accessories as recommended by the manufacturer for applications indicated, as needed to provide a complete cold-formed metal framing system.

2.3 GRADES OF STEEL

A. Steel Sheet: ASTM A 1003, Structural Grade, Type H, metallic coated, of grade ST33H or ST50H as required by performance or as indicated and coated with G60 galvanized coating.

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653, structural steel, zinc coated with G60 galvanized coating and grade as required by structural performance or as indicated.

C. Minimum Base Metal Thickness: 43 mil for brick back-up, 33 mil for other applications.

D. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

2.4 TYPES

A. Structural Stud/Joist (S-Section): Steel studs of size and thickness as required by structural performance or as indicated, with minimum 1.625" flange and flange return lip.

B. Track (T-Section): Standard tracks of size, shape, and thickness as required by structural performance or as indicated, with a minimum flange width of 1.25 inches with no return flange lip.

C. Channel (U-Section): Standard U-section of size, shape, and thickness as required by structural performance or as indicated, with a flange width of 0.500 inches with no return flange lip.

D. Furring Channel (F-Section): Standard F-section (hat-shaped) of size, shape, and thickness as required by structural performance or as indicated.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated of same grade and coating weight used for framing members

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated or as required for structural performance, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces, and girts.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Hot-rolled Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

B. Anchor Rods: ASTM F 1554, Grade 36, threaded carbon-steel, hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.

C. Anchoring to Concrete: See Cast-In-Place Concrete Section for acceptable anchoring processes and products.

D. Powder-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Screws: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

F. Welding Electrodes: E 60 XX, Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: Galvanizing repair paint shall be "ZRC Cold Galvanizing Compound" as manufactured by ZRC Chemical Products or a paint complying with SSPC-Paint 20.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Non-shrink Grout: Premixed, nonmetallic, non-corrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time. The grout strength shall be twice the compressive strength of the supporting concrete but need not be greater than 8000 psi nor shall it be less than 5000 psi.

D. Shims: Load bearing, high-density multi-monomer plastic, non-leaching.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

A. General: Framing components may be prefabricated into panels prior to erection. Fabricate panels plumb, square, true to line and braced, reinforced, and stiffened to resist handling, delivery, and erection stresses. Perform lifting of prefabricated panels in a manner to prevent damage or permanent distortion. All load-bearing stud framing must be fabricated into panels and must be compressed to eliminate gaps at ends of studs.

B. Connections:

1. Type: Fasten cold-formed metal components by any of the following methods or as indicated on the drawings.

   a. welded

   b. screwed

   c. clinch fastening

   d. riveting

   e. Wire tying of framing components shall not be permitted

2. Design Forces: Connections of members shall develop the full allowable tensile force of the members connected unless calculations are submitted substantiating lower forces.

3. Welded Connections: Connection of cold-formed metal components may be made using arc welding methods. All welding shall be performed in accordance with the American Welding Society, AWS D1.3. Welding process along with weld sizes and lengths necessary to develop the member forces specified shall be shown on the shop drawings. Protection of the weld area after welding shall be accomplished using a zinc-rich galvanizing repair paint.

4. Screwed Connections: Connection of cold-formed metal components may be made using self-drilling self-tapping screws. Screw type and size along with the number of screws required to resist the member forces specified shall be shown on the shop drawings. Screw penetration into joined members shall be a minimum of three exposed screw threads.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squarenenss: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Pre-Installation Conference: Prior to start of installation of metal framing systems, meet at project site with installers of other work including door and window frames and mechanical and electrical work. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

B. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

D. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.2 INSTALLATION

A. Install cold-formed metal framing systems according to AISI's "Standard for Cold-formed Steel Framing – General Provisions" and to manufacturer's printed or written instructions and recommendations.

B. Runner Tracks: Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24" o.c. spacing for nail or powder-driven fasteners, or 16" o.c. for other types of attachment. Abutting pieces of track shall be securely spliced together. Provide fasteners at corners and ends of tracks.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements. Splices in axially loaded stud systems shall not be permitted. Splices in other work shall not be permitted unless the splice has been engineered and detailed on the shop drawings.

D. Provide four (4) studs at each intersecting wall and three (3) studs at each corner minimum.

E. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

F. Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and

furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported.

G. Installation of Wall Stud System: Load-bearing studs shall be seated firmly against the track webs with a gap not exceeding 1/8 inch. Connect load-bearing studs to top and bottom runner tracks by either welding or screw fastening as specified at both inside and outside flanges. Install studs at spacing to align directly under joist spacing above but do not exceed 16 inches for load-bearing walls or as shown on the drawings.. Install studs at spacing as shown on the drawings or as required to resist structural loads for non-load-bearing walls,

H. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support using drift clips, vertical deflection clips, or deflection tracks. Frame wall openings larger than 2'-0" square with double stud at each jamb of frame except where more than 2 are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full-height studs of wall. Secure stud system wall opening frame in manner indicated.

I. Frame both sides of expansion and control joints, with separate studs; do not bridge the joint with components of stud system.

J. Horizontal Bridging:

1. Horizontal bridging shall consist of a channel (U-section) attached to each stud using a manufacturer’s clip angle. At stud walls 8 inches or deeper, horizontal shall consist of flat strapping screwed to both flanges of stud wall, and to blocking at 8’-0” on center.

2. Install horizontal bridging in all non-loadbearing exterior cladding stud systems, spaced (vertical distance) at not more than 4'-0" o.c.

3. Provide stud bracing during construction as required for studs to carry construction loads.

K. Sheathing Attachment: Provide attachment of interior and exterior sheathing and wall material to each stud in accordance with structural drawings.

L. Wall Braces: Provide wall braces ("kickers") as shown on the Architectural and Structural Drawings, but not less in size and gage than that of wall stud being braced and not spaced greater than every fourth stud, and first stud from all corners, whether shown on the drawings or not. Provide connection at each end of brace to develop the required force in the brace. Connections to concrete shall be made with expansion anchors having a valid ICC-ES Evaluation Report by ICC Evaluation Service, Inc. and shall be in strict accordance with manufacturers instructions and only if intended for cold-formed metal attachment. Connections to cold-formed metal and structural steel shall be as specified in section on Connections.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Steel framing and supports for countertops.
2. Steel framing and supports for overhead coiling doors.
3. Steel framing and supports for Operable Panel Partitions.
4. Steel framing and supports for projection screens.
5. Miscellaneous steel framing and supports for mechanical and electrical equipment not specified elsewhere.
6. Laboratory Services Frame System
7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
8. Support angles for elevator door sills.
9. Shelf angles.
10. Loose bearing and leveling plates.
11. Miscellaneous steel trim including steel edgings and loading-dock edge angles.
12. Metal bollards.
13. Loose steel lintels.
14. Cast nosings and treads.
15. Sump pit grates for elevator pits.
16. Miscellaneous metal fabrications indicated and required to complete elevator installation.
    a. Sump pit grating covers.
    b. Elevator pit access ladders.
    c. Supports at each floor level for guide rail fastening and intermediate supports indicated for elevator installation.
17. Metal Floor Plate.

1.3 PERFORMANCE REQUIREMENTS

A. General: Fabricate and install the following metal fabrications to withstand the specified structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections.

B. Structural Performance of Aluminum Ladders: Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of loads and stresses within limits and under conditions specified in ICC's International Building Code.

D. Public Toilet Room Countertops: Fabricate and install countertop framing so that, when installed, they are capable of withstanding the following structural loads without exceeding the allowable design working stress of materials, including anchors and connections, or of exhibiting excessive deflections in any of the components making up the countertop:

1. All deadloads.
2. 500 lb live load placed on the countertop.
3. Deflection at Midspan: L/1000 times span or 1/8" whichever is less.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: Submit product data for products used in miscellaneous metal fabrications, including the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Including but not limited to the following:

   a. Steel framing and supports for operable partitions.
   b. Steel framing and supports for overhead doors.
   c. Steel framing and supports for countertops.
   d. Steel framing and supports for mechanical and electrical equipment.

2. Provide templates for anchors and bolts specified for installation under other Sections.
3. For installed metal fabrications indicated to comply with performance requirements, include for information only structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by a qualified professional engineer registered in the State of Florida.

1.5 INFORMATION SUBMITTALS

A. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project with sufficient production capacity to produce required units without causing delay in the Work.

B. Welder Certification: The General Contractor or Construction Manager is responsible for obtaining and retaining welder certifications for any person performing on-site welded steel fabrication or

erection. The certifications must be current and validated by welding logs or certification test(s) conducted with the last two (2) years.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.2, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

A. A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

C. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Galvanizing Requirements: All exterior ferrous metals shall be hot-dip galvanized after fabrication.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.4 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304.

B. Pipe: ASTM A 312, Grade TP 304.

C. Plate and Sheet: ASTM A 666, Type 304.

D. Fittings: ASTM A 666, Type 316.

E. Stainless Steel Cable: ASTM A 492, Type 316.

F. Brick Shelf Angles: Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

G. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

H. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

2.5 PAINT

A. Shop Primer for Ferrous Metal: Refer to Division 5 “Shop-Applied Primers” and Division 09 sections for interior and exterior painting.

2.6 FASTENERS

A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

D. Machine Screws: ASME B18.6.3.

E. Lag Bolts: ASME B18.2.1.

F. Plain Washers: Round, carbon steel, ASME B18.22.1.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2. Material for Anchors in Exterior Locations: Alloy Group 1 (A1) stainless-steel bolts complying with ASTM F 593 (ASTM F 738M) and nuts complying with ASTM F 594 (ASTM F 836M).

2.7 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Provide a primer with good resistance to normal atmospheric corrosion and that is compatible with topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20 and ASTM A 780.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.8 LABORATORY SERVICES FRAME SYSTEM

A. Square Frame System:

1. Square Frame system on a 4’-0” x 4’-0” grid. Depth to be determined loads imposed and design provided by manufacturer

2. Full System dimensions shown on drawings QL407 and QL401

3. Use size and thickness to product strength and durability in the finished product for the utility states below

4. Steel rods to comply with section 05 50 00

5. System connections to be specialty item consisting of threaded / bolted nodes

6. System shall support a point load of 100lbs at any location

7. Components to be powder coated, white, black or grey. Final color sample to be selected by architect.

8. Number of connections to be coordinated with structural drawings.

2.9 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Galvanize all exterior ferrous miscellaneous metal items embedded in concrete. Galvanize all other items where specified or shown.

1. Exterior miscellaneous metal items are defined as those items which are indicated to be installed in areas exposed to conditions which are not controlled by building heating and cooling systems.
2. Interior miscellaneous metal items are defined as those items which are indicated to be installed in areas exposed to conditions which are controlled by building heating and cooling systems.

K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive fasteners and similar items.

L. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

M. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

2.10 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

1. Elevator hoistway beams.
2. Elevator support sill supports.
3. Overhead coiling door supports.
4. Operable Panel Partition supports.
5. Projection screens supports.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts if units are installed after concrete is placed.

3. Equip units with integrally welded anchors for casting into concrete or building into masonry.

C. Countertop Framing: Custom fabricate countertop framing, using miscellaneous steel shapes and plates, and cold finished mild steel bars at exposed conditions, for support framing and plywood, to the thicknesses, sizes and shapes shown, and as required to produce work of adequate strength and durability, without objectionable deflections. Use proven details of fabrication, as required, to achieve proper assembly and alignment of the various components of the work. Provide countertop framing in the following areas:

1. Public toilet rooms.
2. Locker rooms.
3. Reception desk.

D. Galvanize miscellaneous framing and supports in exterior locations.

E. Miscellaneous Metal Framing For Electrical Support Systems: If electrical equipment is attached to support framing, the Electrical Contractor will provide and install that metal framing.

F. Use of ink marking pens on surfaces of any kind of materials is prohibited as such marks bleed through paint and other finishes.

G. Lintels for Plumbing, HVAC And Electrical Installations: The General Contractor shall furnish lintels for all openings through walls when openings are shown on the architectural or structural (General Contract) drawings. Note all such lintels and openings to require coordination of work and exact locations, by affected contractors. All such plumbing, HVAC, electrical, and sprinkler openings must be coordinated and shown on the Architectural and/or Structural Drawings.

2.12 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates after fabrication.

2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.14 MISCELLANEOUS STEEL TRIM

A. Fabricate units from structural-steel shapes of profiles shown with mitered corners, continuously welded joints, and smooth exposed edges.

B. Galvanize miscellaneous steel trim at exterior locations.

~~2.15 ALTERNATING TREAD DEVICES~~

~~A. Alternating Tread Devices: Fabricate alternating tread devices to comply with ICC's International Building Code. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.~~

~~1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:~~

~~a. Lapeyre Stair Inc.~~
~~b. Schmidt Structural Products; a subsidiary of Penco Products, Inc.~~
~~c. Or equal.~~

~~2. Three stringer design, with alternating treads welded to the stringers.~~

~~3. Alternating Tread Stairs as follows:~~

~~a. (1) 14'-0" vertical travel- 56 degree with optional straight rail handrail @ 42"~~
~~b. (1) 14'-0" vertical travel- 56 degree with optional straight handrail at 42" @ roof hatch to rail @ 5/3/4"~~
~~c. Ladders to have 30" x 60" 180° Left Turn Switchback Intermediate Platform~~
~~d. Finish: carbon steel with powder coated finish (Standard Iron Grey).~~

~~2.16~~2.15 METAL LADDERS

A. General: Fabricate exterior aluminum ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.

1. Comply with ANSI A14.3, unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.

B. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges, spaced 18 inches apart.

C. Bar Rungs: 3/4-inch- diameter steel bars, spaced 12 inches o.c.

D. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.

E. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets. Size brackets to support design loads specified in ANSI A14.3.

~~2.17~~2.16 BOLLARDS

A. Bollards: Fabricate pipe bollards from Schedule 40 steel pipe.

1. Size: As indicated.

B. Finish: Refer to Division 09 Section High Performance Coatings for final finish.

1. After final paint coating has been applied apply two coats of fluid-applied waterproofing to surfaces below top of concrete slab or asphalt paving.

~~2.18~~2.17 LOOSE STEEL LINTELS

A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

B. Weld adjoining members together to form a single unit where indicated.

C. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.

D. Galvanize loose steel lintels located in exterior walls.

~~2.19~~2.18 SUMP PIT GRATE

A. Fabricate sump pit grate from swage locked aluminum bars and rods.

1. Product and Manufacturer: Series GAL-2, Swage Locked Aluminum Grating; McNichols Co or equal.
2. Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

~~2.20~~2.19 MTL1: METAL FLOOR PLATE

A. Stainless Steel Floor Plate, also known as Stainless Diamond Plate or Stainless Tread Plate has a raised diamond lug pattern that provides excellent skid resistance for a wide range of applications where corrosive resistance is important.

B. Specifications: AISI 304, ASTM A793, medium pattern, non-polished finish.

1. Thickness: 16 GA or 0.0625 inches.
2. Mechanical Properties: Tensile = 85,000 +/-, Yield = 34,000 +/-

~~2.21~~2.20 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

~~2.22~~2.21 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

~~2.23~~2.22 STAINLESS STEEL FINISHES

A. Dull Satin Finish: No. 6.

1. Remove tool and die marks and stretch lines or blend into finish.
2. Grind and polish surfaces to produce uniform finish indicated, free of cross scratches.
3. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

3.3 INSTALLING PIPE GRID

A. Examine substrates and structural framing to which open pipe grid attach or abut, with Installer present, for compliance with requirements specified in this section.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation: Coordination: Furnish layouts for cast-in-place anchors, clips, and other ceiling anchors whose installation is specified in other Sections.

C. Contractor shall be responsible for coordinating with HVAC and other trades the proper location of hangers to structural steel.

D. Install pipe grid according to manufacturer's instructions and approved shop drawings.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Clean stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.5 PROTECTION

A. Protect finishes from damage during construction period. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Steel stairs with concrete-filled treads and two part cast-in-place nosings.
2. Alternating Tread Stair.

B. Related Sections include the following:

1. Division 03 Section "Cast-In-Place Concrete" for concrete fill for treads and landings.
2. Division 09 “Clear Concrete Sealants” for sealing concrete stair treads and landings.

1.3 STANDARDS

A. General: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following.
1. American Institute of Steel Construction (AISC) "Manual of Steel Construction".
2. American Iron and Steel Institute (AISI) "Cold Formed Steel Design Manual".
3. American Welding Society (AWS):
   a. AWS D1.1 "Structural Welding Code - Steel."
   b. AWS D1.3 "Structural Welding Code - Sheet Steel."
   c. AWS D5.1 "Specifications for Carbon Steel Electrodes for Shielded Metal Arc Welding."
   d. AWS D5.18 "Specifications for Carbon Steel Filler Metals for Gas Shielded Arc Welding."
4. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP-510 "Metal Stairs Manual."
5. Industrial Fasteners Institute (IFI) "Fastener Standards".
6. Steel Structure Painting Council (SSPC) "Steel Structures Painting Manual, Volume 2, Systems and Specifications."

B. Regulatory Requirements: Comply with the requirements of Part 1910 of the Occupational Safety and Health Standards (OSHA), and the American Disabilities Act (ADA) as applicable to stairs, handrails and the protection of openings.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

B. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of loads and stresses within limits and under conditions specified in Florida Building Code.

1.5 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Prefilled metal-pan-stair treads.
2. Nonslip aggregates and nonslip-aggregate finishes.
3. Abrasive nosings.
4. Paint products.

B. Shop Drawings: Show fabrication and installation details for metal stairs. Include plans, elevations, sections, and details of metal stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Engineered Submittal: For stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.7 QUALITY ASSURANCE

A. Special Inspections: Fabrication shop and assemblage of components in the field shall be subject to Special Inspections.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Florida and who is experienced in providing engineering services of the

kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.

C. Fabricator Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Stairs: Commercial class.
2. Industrial-Type Stairs: Industrial class.
3. Ornamental Stairs: Architectural class.

E. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

D. Coordinate fabrication and installation with adjacent building structure and systems and verify all governing or related dimensions to ensure an accurate and precise installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers providing products in compliance with requirements include the following or equal:

1. American Stair; Romeoville, Ill.
2. Sharon Stairs; Integrated Products Group, Duluth GA.
3. Machuch Steel Products; Southeastern Stair & Rail LLC; Augusta, GA

2.2 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel plates, channels, or tubes.

   a. Provide closures for exposed ends of channel or tube stringers.

2. Construct platforms of steel plate, channel, or tube headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.0677 inch.
1. Steel Sheet: Uncoated cold or hot rolled steel sheet.
2. Steel Sheet: Galvanized steel sheet, where indicated.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding.
4. Form tread pans and risers in a continuous piece to receive concrete fill and epoxy terrazzo treads and risers.
5. Shape metal pans to include nosing integral with riser.
6. Fasten countersunk bolts or stud welded clips through tread pans and platforms to fasten welded wire fabric for concrete fill.
7. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
   a. Smooth Soffit Construction: Construct subplatforms with smooth soffits.
   b. Provide metal bases formed of structural steel of the section indicated and metal decking or metal pans of section and gage as required to meet performance requirements.
   c. Fasten countersunk bolts or stud welded clips through decking or pans to facilitate the fastening of metal reinforcement mesh for concrete fill.

2.3 TWO PART ABRASIVE NOSINGS

A. Extruded Units: Aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions. Nosings shall be full length of steps, less 1/8-clearance.

1. Available manufacturers and products or equal:

   a. American Safety Tread Co; Type PF-311
   b. Balco Inc; Two Component Nosings.
   c. (Basis of Design) Nystrom; STTF series Model P3.375E.

2. Nosings: Two-piece units, 3 inches wide, with subchannel for casting into concrete.
3. Width: 3.375-inches.

4. Base and Nosing: Extruded aluminum type 6063-T5, mill finish

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

D. Accessories:

1. Provide detectable Warning Strips at stairs as required by code.

2.4 ALTERNATING TREAD DEVICES

A. Aluminum Alternating Tread Devices: Fabricate alternating tread devices to comply with Florida Building Code. Aluminum Alternating Tread Stair and Components: Including stair, mounting brackets and handrails on both sides.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. (Basis of Design) Precision Ladders

2. Lapeyre Stair Inc.

C. Three stringer design, with alternating treads welded to the stringers.

1. Capacity: Unit shall support a 1,000 lb (227 kg) total load without failure.

2. Degree of Incline: 68 degrees.

3. Performance Standard: Units designed and manufactured to meet or exceed OSHA 1910.25.

D. Components:

1. Stair Side Stringers: 3-inch by 2 inch by 1/8 inch extruded 6005-T5 aluminum tubing. Pitch: 56 or 68 degrees.
2. Stair Center Stringer: 10 inch by 1/4 inch extruded 6005-T5 aluminum flat bar. Note: Neoprene trim adhered to front edge of center stringer to protect climber.
3. Stair Treads: 1-inch aluminum Bar Grating, 9 13/16” deep by 9 7/8” wide on hatch-access models (11 7/8” wide on Walk-thru models).
4. Stair Mounting Brackets: 6 inch by 1/4 inch aluminum flat bar
5. Handrails: 1-1/4 inches Schedule 40, 6005-T5 aluminum pipe provided with internal aluminum fittings.
6. Finishes:
   a. Standard: Mill finish on aluminum stair components.

E. Fabrication: Completely fabricate stair ready for installation before shipment to the site.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Perform welding in accordance with Structural Welding Code.
2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
3. Obtain fusion without undercut or overlap.
4. Remove welding flux immediately.
5. Weld exposed corners and seams continuously, unless otherwise indicated.
6. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 METALS

A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, and other imperfections where exposed to view on finished units. Do not use steel sheet with variations in flatness exceeding those permitted by referenced standards for stretcher-leveled sheet.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Uncoated, Cold-Rolled Steel Sheet: Commercial quality, complying with ASTM A 366/A 366M; or structural quality, complying with ASTM A 611, Grade A, unless another grade is required by design loads.

D. Uncoated, Hot-Rolled Steel Sheet: Commercial quality, complying with ASTM A 569/A 569M; or structural quality, complying with ASTM A 570/A 570M, Grade 30, unless another grade is required by design loads.

E. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.7 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts for exterior stairs.

D. Machine Screws: ASME B18.6.3.

E. Plain Washers: Round, ASME B18.22.1.

F. Lock Washers: Helical, spring type, ASME B18.21.1.

G. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.8 PAINT

A. Shop Primer for Ferrous Metal: Refer to Division 09, Section “Painting”.

2.9 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Provide a primer with good resistance to normal atmospheric corrosion and that is compatible with topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20 and ASTM A 780.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
1. Produce a concrete mix with a low slump suitable for placement.
2. Provide coarse aggregate sizes suitable for thickness of concrete fill at treads and platforms.

2.10 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, handrails, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Commercial class, unless otherwise indicated.

C. Shop Assembly: Preassemble stairs in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

D. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Shear and punch metals cleanly and accurately. Remove sharp or rough areas on exposed surfaces.

E. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously, unless otherwise indicated.
5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

2.11 FINISHES

A. Comply with NAAMM'S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:

1. Interiors (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."

D. Apply shop primer to prepared surfaces of metal stair components, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

E. Refer to Division Section “Painting”, for final finish.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:

1. Perform welding in accordance with Structural Welding Code.
2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
3. Obtain fusion without undercut or overlap.
4. Remove welding flux immediately.
5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Place and finish concrete fill for treads and platforms to comply with Division 3 Sections "Cast-in-Place Concrete."

H. Leave work exposed to view, including stair soffits, clean, smooth and neatly finished.

I. Include supplementary parts necessary to complete each item, though such work is not definitely shown or specified.

J. Coordinate and schedule this work with the work of other trades. Furnish anchors, fastenings and other items required for securing the steel stairs work to adjacent construction.

3.2 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.3 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Material Completion.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055100

SECTION 055213 - STAIR RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Painted steel pipe and tube railings at interior fire stairs.

B. Related Sections include the following:

1. Division 05 “Shop Primers”
2. Division 05 "Metal Stairs.”
3. Division 09 “Interior Painting.”

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing materials based on the following:

1. Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."
2. Cold-Formed Structural Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."

B. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding structural loads, in accordance with the Code, without exceeding the allowable design working stress of materials for handrails, railings, anchors, and connections:

1. Top Rail of Guards: Capable of withstanding the following loads applied as indicated:

   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. applied horizontally and concurrently with uniform load of 100 lbf/ft. applied vertically downward.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.

2. Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:

   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. applied in any direction.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.

3. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 200 lbf applied to 1 sq. ft. at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.

   a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guards.

C. NFPA Compliance: Handrails and guardrails shall comply with 2015 edition of NFPA 101 Life Safety Code and the Florida Fire Code 5th Edition 2015.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product data for prefabricated handrails, railings, woven wire infill panels and accessories.

B. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.

1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 QUALITY ASSURANCE

A. Workmanship: Design/Builder and the University are the authority to approve the work and for determining the quality of appearance and standard of high-quality, defect-free work. The Design/Builder and the University shall have absolute authority to reject units not meeting their approval.

B. Source Limitations: Obtain each type of handrail and railing through one source from a single manufacturer.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.6 STORAGE

A. Store handrails and railings in a dry, well-ventilated, weathertight place.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

A. Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates, and directions for installing anchorages. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS

A. General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

2.2 STEEL

A. Steel: Provide steel in the form indicated, complying with the following requirements:

1. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:

a. Type F, or Type S, Grade A, standard weight (Schedule 40), unless another grade and weight are required by structural loads.

B. Steel Tubing: Cold-formed steel tubing, ASTM A 500, Grade A, unless another grade is required by structural loads.

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.3 FASTENERS

A. General: Provide the following:

1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

a. Countersink and set fasteners flush with adjacent surfaces where exposed to view.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections indicated for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Anchors: Provide chemical anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.4 WELDING MATERIALS

A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 9, section Painting.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION

A. General: Fabricate handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

1. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Form changes in direction of railing members as follows:

    a. As detailed.

3. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
4. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

    a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    b. Obtain fusion without undercut or overlap.
    c. Remove flux immediately.
    d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

B. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

1. Provide inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

C. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

F. Close exposed ends of handrail and railing members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch or less.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.7 STEEL FINISHES

A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed handrails and railings:

1. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush-off Blast Cleaning."

B. Apply shop primer to prepared surfaces of handrail and railing components, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Stripe paint edges, corners, crevices, bolts, and welds.

C. Final Finish: Refer to Division 09 Section “Painting.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of handrail and railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

C. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ATTACHING HANDRAILS TO WALLS

A. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in epoxy-type anchors.
2. For hollow masonry anchorage, use toggle bolts.

3.5 CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 section Painting.

3.6 PROTECTION

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion and no sooner. Protective covering shall be removable and replaceable for inspection prior to Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal frames and supports for gratings.
2. Below grade gratings at Sump pump with hinge for access.

B. Related Sections:

1. Division 01 “Sustainable Design Requirements” for additional LEED requirements.
2. Division 05 “Metal Fabrications.”

1.3 PERFORMANCE REQUIREMENTS

A. Comply with the following reference standards:

1. NAAMM MBG 531-2009: Metal Bar Grating Manual

2. NAAMM MBG 532-2000: Heavy-Duty Metal Bar Grating Manual

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
2. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft.
3. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
4. Limit deflection to L/360or 1/4 inch, whichever is less.

1.4 ACTION SUBMITTALS

A. Product Data: for gratings.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer or the manufacturer's

engineer responsible for their preparation indicating that the shop drawings meet the requirements of the design analysis.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Special Inspections: Fabrication shop and assemblage of components in the field require Special Inspections.

B. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual".

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

D. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project for a minimum of 5 years, with sufficient production capacity to produce required units without causing delay in the Work.

E. Gratings Manufacturer: A manufacturer specializing in the fabrication of the type of units required who has tested the units for load-bearing strength and deflection, and has currently published load tables based on recognized test procedures.

F. Engineer Qualifications: Professional engineer licensed to practice in the State of Florida and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METAL BAR GRATINGS

A. Available manufacturers include but are not limited to the following or equal:

1. AMICO Gratings, Birmingham, AL
2. BarnettBates, Joliet, IL
3. Ohio Gratings, Canton, OH

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

2.3 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2.4 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.

2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior and interior where subjected to moisture.

2.5 STEEL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

D. Shop prime gratings, frames and supports not indicated to be galvanized unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

SECTION 057100 –DECORATIVE METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Decorative Metal Stair Assemblies as indicated on the drawings and including the following:

1. Assembly includes precast terrazzo risers/treads and precast terrazzo landings.
2. Glazed decorative metal railings.
3. Exposed, painted steel stringers and structural components.

B. Contractor shall be responsible for coordination of all components of Decorative Metal Stair Assemblies including:

1. Interior exposed and painted structural steel-framed stairs including stringers and all required supports.
2. Engineering, manufacture, transportation, and erection of cast terrazzo stairs including treads, risers and landings (specified in this section).
3. Handrails: brushed stainless steel.
4. Decorative clear tempered glazed railings.

C. Related Work fabricated and installed in other Sections includes:

1. Division 05 “Structural Steel Framing” for steel structure and stringers.
2. Division 05 "Decorative Glazed Railings" for glazed railings.

D. Related Sections:

1. Division 05 "Cold Formed Metal Framing" for additional requirements for interior structural metal framing.
2. Division 05 "Metal Stairs" for additional requirements.
3. Division 07 "Joint Sealants" for sealants installed with precast terrazzo.
4. Division 09 "Gypsum Board Assemblies" for cladding and metal backing for anchoring railings.
5. Division 09 "Interior Painting" for shop- and field-applied painting of exposed steel to be painted.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review dust-control procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For all items pertaining to decorative metal stairs.

B. Shop Drawings:

1. Decorative Metal Stair Assemblies: Include plans, elevations, sections, details, and attachments to other work.

2. Structural steel: Show assembly of components including the following:

   a. Stringers.
   b. Platforms, headers, struts, and hangers.
   c. Supplemental steel framing for connection and alignment of threaded rod hangers to structural steel building framing.
   d. Railings, handrails, guardrails, and brackets.
   e. Reinforcements, anchors, welded and bolted field and shop connections (size and location), and other supplemental information.
   f. Submit details drawn to scale not less than 1-1/2" = 1'-0".
   g. Provide templates for anchors and bolts specified for installation under other Sections.

3. Precast Terrazzo Stairs:

   a. Erection drawings shall show dimensions for proper fabrication; reinforcing steel sizes, grades and locations; inserts accessories and handling methods; calculations for reinforcing; details, sections, jointing, anchoring, and all other necessary information.
   b. Tests and Reports: Perform all concrete testing in accordance with PCI MNL−116 requirements.

C. Samples for Verification: For products involving selection of color, texture, or design.

D. Engineered Submittals: For Decorative Metal Stair Assemblies to comply with performance requirements and design criteria include for information only, structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by a qualified professional engineer registered in the state of Florida.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For precast terrazzo to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer who is a contractor member of NTMA.
2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
3. Engage an installer who has satisfactorily completed not less than three projects of similar complexity and scope to that specified for this project.

B. Manufacturer Qualifications: Manufacturer shall have not less than ten years satisfactory experience in the manufacture of precast terrazzo stairs and continuous membership in the NTMA for the same period of time.

1.8 COORDINATION

A. Specialty Contractor and Contractor shall coordinate the work of all trades to ensure the timely installation of structural steel supports prior to the erection of precast terrazzo stairs.

B. Coordinate installation of anchorages for structural steel supports and precast terrazzo stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

C. Structural Steel: Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

D. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

E. Coordinate fabrication, finishing and installation of Decorative Metal Guardrails.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling:

1. Carefully transport and handle precast terrazzo stairs so as to prevent soiling or damage. Store clear of ground in manner to prevent cracking, distortion, warping and to protect from damage and dirt. Soiling or staining of precast units may be cause for rejection of units. Lift and support units only at designated lifting or supporting points as shown on approved shop drawings.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Sole Source: Provide precast terrazzo treads, risers and landings, by the same manufacturer.

B. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

C. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

D. Manufacturers providing products in compliance with requirements include the following or equal:

1. Precast Terrazzo Enterprises, Inc.
2. Tectura Designs, a Wausau Tile Brand.
3. Terrazzco; Concord Terrazzo Company

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Decorative Metal Stair Assemblies shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Precast terrazzo stairs and landings:

   a. Shall be designed to support the full dead load plus 100 psf live load.
   b. Short term and long-term deflection shall be no greater than Table 9.5 (b) of ACI−318.

2. Structural Metal Stair stringers and supports:

   a. Uniform Load: 100 lbf/sq. ft + dead load of precast terrazzo stairs and landings.
   b. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
   c. Uniform and concentrated loads need not be assumed to act concurrently.
   d. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
   e. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

B. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

1. Comply with NTMA Technical Bulletin No. 36, Terrazzo Coefficient of Friction.

2.3 PRECAST TERRAZZO STAIRS

A. Description: Custom precast epoxy-resin terrazzo treads, risers and intermediate landing platforms.

B. Aggregate: as selected by Design Professional and as follows:

1. Marble complying with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

C. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, color stable, and compatible with matrix binder, matching terrazzo flooring.

D. Epoxy-Resin Matrix: Provide matrix complying with NTMA's "Guide Specification for Epoxy Terrazzo" in colors required to terrazzo flooring.

2.4 PRECAST TERRAZZO INSTALLATION MATERIALS

A. Polymer-Modified Cementitious Mortar:

1. Description: Premium-grade, single-component, ultra high-performance, polymer-modified thin-set Portland cement mortar conforming to ANSI A118.4.
2. Products:

a. (Basis of Design) MAPEI; Ultraflex 3” by Mapei Corp.
b. Custom Building Products.
c. Laticrete International, Inc.

3. Color: White.

B. Epoxy Grout:

1. Description: Water-cleanable epoxy resin grout conforming to ANSI A118.3.
2. Manufacturer’s: Mapei Corp, Custom Building Products, or Laticrete or equal.
3. Color: As selected by Design Professional.

2.5 ABRASIVE BARS AT STAIR NOSINGS

A. Proprietary, solid slip-resistant epoxy abrasive tapered bars for recessed installation in precast concrete treads. Adhered to recessed surface; no mechanical fasteners required. Meet ADA guidelines for slip resistance. Abrasive strips shall be full length of steps.

1. Available manufacturers and products or equal:

a. Balco Inc; AS-Angled Strips; model AS-2 Non-slip abrasive bar.

B. Product Characteristics:

1. Dimensions:

a. Vertical Depth: 1/2-inch with 1/8" above tread finish plane.
b. Taper: 1/4" to 3/16"
c. Lengths: 4'-0" maximum.

2. Materials:
a. Two-part epoxy and colored quartz abrasive

C. Performance:

1. Static coefficient of friction:
a. Dry: 1.19 per ASTM D2047-11
b. Wet: 1.10 per ASTM D2047-11

D. Color: As selected by Design Professional from manufacturer's standard Abrasive Options.

E. Construction Adhesive: as recommended by manufacturer.

~~2.5~~2.6 PRECAST TERRAZZO ACCESSORIES

A. Cleaner: Chemically neutral cleaner having a pH factor between 7 and 10 that is biodegradable, phosphate free, and supplied, required, recommended, approved or accepted by the by sealer manufacturer for use on the installed terrazzo flooring.

B. Sealer: Slip- and stain-resistant penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's “Terrazzo Specifications and Design Guide” for terrazzo type indicated.

C. Other Accessories: Provide other accessories and similar secondary items as supplied, required, recommended, approved or accepted by the manufacturer.

D. Joint Adhesives: Provide types as recommended by the manufacturer of precast terrazzo. Colors shall match terrazzo material. Joint adhesive shall create inconspicuous, non-porous joints and shall not contain urea formaldehyde

~~2.6~~2.7 PRECAST TERRAZZO FABRICATION

A. Precast Terrazzo Units: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Finish exposed-to-view edges and reveals to match face finish.

B. Sizing Tolerances:

1. All units to conform to shop drawings with a 1/16" tolerance in dimension

C. Precast Surfaces and Edges:

1. All exposed edges to be ground and polished with a minimum of 1/16" bevel.
2. All finished surfaces to be ground and polished, free of holes and to have overall uniformity in matrix and aggregate.
3. All precast epoxy terrazzo finished surfaces to be sealed with a sealer approved by manufacturer.

~~2.7~~2.8 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate steel stringers with dimensions as indicated on approved shop drawings.
2. Construct platforms of steel plate or channel headers and miscellaneous framing members to comply with performance requirements and as in approved shop drawings.
3. Weld stringers to headers; weld framing members to stringers and headers.

B. Refer to Division 05 "Metal Stairs" for requirements.

~~2.8~~2.9 FABRICATION - GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

~~2.9~~2.10 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

~~2.10~~2.11 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

~~2.11~~2.12 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36..

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

~~2.12~~2.13 FASTENERS

A. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

B. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be shop primed with zinc-rich primer.

C. Machine Screws: ASME B18.6.3.

D. Lag Screws: ASME B18.2.1.

E. Plain Washers: Round, ASME B18.22.1.

F. Lock Washers: Helical, spring type, ASME B18.21.1.

G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

~~2.13~~2.14 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Stairs shall have painted finish, color to be selected by Architect from manufacturer's standard and custom colors.

C. Finish metal stairs after assembly.

D. Refer to Division 09 "Interior Painting" for additional requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.

1. Examine substrates supporting precast terrazzo risers, treads and landings, and other conditions under which such items are installed.

B. Verify that work performed as part of the work of other Sections conforms to the manufacturer's installation tolerance requirements; provides true, flat, and level surfaces; and satisfies all other conditions relating to the quality of installation, durability, appearance, and performance;

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing Decorative Metal Stair Assemblies to in-place construction. Include threaded fasteners for concrete inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stair components by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated. Refer to Division 05 "Structural Steel Framing," Division 05 "Metal Stairs" for additional requirements.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION PRECAST TERRAZZO STAIRS

A. General:

1. Comply with the manufacturer's installation instructions for installing precast terrazzo treads, risers and landings.
2. Use materials and methods required, recommended, approved, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
3. Set items plumb, level, and square, with flush well-fitted joints, and in alignment with adjacent construction

B. Erection:

1. Work to be performed by manufacturer-approved erector for precast terrazzo stairs.
2. Install in accordance with approved shop drawings and manufacturer's recommended installation procedures.
3. Handling and Erection:

   a. Temporarily stabilize all precast work until permanent connections have been completed and the framework is stable.

C. Accurately form intersections and returns. Perform cutting and drilling of precast terrazzo stairs without marring visible surfaces. Carefully grind cut edges of precast terrazzo stairs abutting trim, finish, or built-in items for straight aligned joints.

1. Grout terrazzo joints in conformance with the requirements of ANSI A108.10.
2. Form joints between components, using manufacturer's joint adhesive; without conspicuous joints

D. Grouting:

1. After precast terrazzo units have been placed and secured, grout open spaces at connections and joints between platforms and stairs, and between platforms and floor plank.
2. Place grout in a manner to finish smooth, plumb, and level with adjacent concrete surfaces.

E. Welding:

1. Welding shall be continuous with Low−Hydrogen rods per AWS A5.1 or A5.5

3.4 INSTALLATION RAILINGS

A. Refer to Division 05 "Decorative Metal Railings" for requirements.

3.5 FINISHING STRUCTURAL STEEL

A. For finish exposed steel, refer to “Division 05 “Shop Applied Primers” and “Interior Painting” for requirements.

3.6 REPAIRS

A. Repair: Repair or refinish items that:

1. Are damaged, loose, chipped, broken, stained, or corroded;
2. Have damaged, loose, chipped, broken, stained, or corroded parts, components, accessories, and similar items; or
3. Do not match the appearance of adjacent surfaces, materials, or finishes, as determined by the Design Professional.

B. Arrange and pay costs for replacing items that cannot be satisfactorily repaired or refinished in a manner that both matches adjacent undamaged areas and shows no evidence of repair or refinishing, as determined by the Design Professional.

C. Touchup Painting: Immediately after erection of steel structural components and framing, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

3.7 CLEANING

A. Cleaning Installed Work:

1. Remove protective materials after installation.
2. Clean surfaces exposed to view using cleaning agents, equipment, tools, and procedures supplied, required, recommended, approved, or accepted by the manufacturer.

    a. Protect other work from staining or damage caused by cleaning operations.
    b. Remove grout residue from precast terrazzo specialty as soon as possible. Clean grout smears and haze from precast terrazzo specialty in conformance with the manufacturer's application instructions, but not sooner than 10 days after installation.
    c. Only use cleaners recommended by manufacturer, and only after determining that cleaners are safe to use by testing samples of precast terrazzo and other surfaces.
    d. Protect metal surfaces from effects of cleaning. Flush surfaces with clean water before and after cleaning.
    e. Do not use cleaning materials or processes that could change the appearance of exposed finishes or damage adjacent materials.
3. Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
4. Replace items that cannot be satisfactorily cleaned, as determined by the Design Professional.

END OF SECTION 057100

SECTION 057313 – GLAZED DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Interior Rails: Aluminum Base Shoe with tempered glass infill Glass Railing System

B. Related Sections:

1. Division 05 "Decorative Metal Stairs" for precast terrazzo stairs with Glazed Decorative Metal Railings."
2. Division 08 “Glazing” for additional requirements.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill Area of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

3. Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of railings assembled from standard components.
2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, and attachment details.

1. Engineered Submittals: For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Welded connections.
4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

1.5 INFORMATION SUBMITTALS

A. Qualification Data: For manufacturer certified installer.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.6, "Structural Welding Code--Stainless Steel."
3. AWS D1.2, "Structural Welding Code--Aluminum."

C. First Installed Work Mockups: Build mockups in place to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 GLAZED DECORATIVE METAL RAILINGS

A. Structural Glass balustrade system with compression set base shoe system.

B. Manufacturers:

1. Trex Commercial Products (Basis of Design)
2. Livers Bronze
3. Q-Railing
4. CRL Blumcraft
5. Wagner Companies
6. VIVA Railings, LLC, Carrollton, TX.
7. View Rail
8. Approved Equal

C. Product: (Basis of Design) TrackRail "Glass Railing System."

D. Components:

1. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
   a. Glass Color: Clear.
   b. Fully tempered minimum 1/2-inch thick at 5'-0" span.

2. Top Rail: "U" Cap Top Rail.
   a. Option#1 – Aluminum Powder Coated Finish or Anodized
   b. Option#2 - Stainless Steel, Type 304, #6 satin.

3. Handrail: 1.5 inch diameter round tubing. Finish to Match Top Rails/Cap

4. Base Shoe:
   a. Aluminum Mounting Shoe Base: 2-1/2” x 4-1/4” profile/similar; Dry Set glazing continuous compression system.
   b. Cladding: Finish to match Top Rails/Cap.
      1) Option#1 – Aluminum Powder Coated Finish or Anodized
      2) Option#2 - Stainless Steel, Type 304, #6 satin.

5. Wall/Floor-mounted rail: 1.5 inch diameter round tubing. Finish to Match Top Rails/Cap

6. Finish: Powder Coated color to be selected by Architect for Aluminum Finish
   a. Option#1 – Aluminum Powder Coated Finish or Anodized
   b. Option#2 - Stainless Steel, Type 304, #6 satin.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails, unless otherwise indicated.

1. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
2. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

2.3 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304.

B. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Grade MT 304.

2.4 FASTENERS

A. General: Provide the following:

1. Stainless-Steel Components: Type 304 stainless-steel fasteners.
2. Dissimilar Metals: Type 304 stainless-steel fasteners.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work, unless exposed fasteners are unavoidable.

1. Provide tamper-resistant flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. Anchors: Provide chemical anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

A. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION

A. General: Fabricate railings in accordance with approved shop drawings and to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for

reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

H. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

I. Form changes in direction as follows:

1. As detailed.

J. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of hollow railing members with prefabricated end fittings.

L. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material, or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

O. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 GLAZING PANEL FABRICATION

A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces.
2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

B. Structural Glass Balusters: Factory-bond glass to aluminum base and top-rail channels in railing manufacturer's plant using glazing cement to comply with manufacturer's written specifications**, unless field glazing is standard with manufacturer**.

C. Structural Balusters: Provide **tempered** glass panels.

D. Structural Balusters: Provide thermoformed, curved, plastic glazing panels for curved sections and [**tempered**] [**laminated, tempered**] glass panels for straight sections.

E. Infill Panels: Provide **tempered** or **laminated tempered** glass panels **for both straight and curved sections**.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STAINLESS-STEEL FINISHES

A. General: Remove tool and die marks and stretch lines or blend into finish.

1. Grind and polish surfaces to produce uniform finish indicated, free of cross scratches.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Stainless Steel: NAAMM AMP 503; No. 6 satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Corrosion Protection: Coat concealed surfaces of aluminum and copper alloys that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Welded Connections: Unless otherwise indicated, use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.

B. Nonwelded Connections: Where indicated, use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and

B. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material

C. Anchor posts with floor or anchor flanges to metal surfaces as required by conditions, connected to posts and to metal supporting members as follows:

1. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.5 INSTALLING GLASS PANELS

A. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.

1. Attach base channel to building structure, then insert glass into base channel and dry set using a continuous mechanical compression along the run of glass.

a. Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.

2. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
3. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

B. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

3.6 ANCHORING RAILING ENDS

A. Anchor railing ends to concrete and masonry with anchors and bolts.

B. Anchor railing ends to metal surfaces as indicated.

3.7 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use epoxy anchors.
2. For hollow masonry anchorage, use toggle bolts.

3. For steel-framed gypsum board partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
4. For steel-framed gypsum board plaster partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: University may engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Payment for these services will be made by University.

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and will comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

3.10 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 057313

SECTION 061053 – MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wood blocking and nailers.
2. Rooftop equipment bases and supports.
3. Wood furring and grounds.
4. Plywood backing panels.

B. Related Requirements:

1. Division 06 Section "Sheathing" for sheathing.
2. Division 07 “Flexible Flashing.”

1.3 REFERENCES

A. American Wood-Preservers' Association

1. AWPA C2-01: Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
2. AWPA C20-99: Structural Lumber - Fire-Retardant Treatment by Pressure Process
3. AWPA C27-99: Plywood - Fire-Retardant Treatment by Pressure Process
4. AWPA M4-01: Care of Preservative-Treated Wood Products

B. Code of Federal Regulations

1. 40 CFR, Part 59, Subpart D-2002: National Volatile Organic Compound Emission Standards for Architectural Coatings

1.4 DEFINITIONS

A. Miscellaneous Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise indicated.

B. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

C. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.5 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. For exterior rough carpentry, include fastening schedule.
2. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
3. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
4. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
5. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

D. Pre-Installation Conference: Include Commissioning Agent, Owner's representative, Contractor to review requirements for exterior rough carpentry related to the roof system, roof equipment supports and roof curbs.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation.

B. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Regional Materials: Dimension lumber, except treated materials, shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Urea-Formaldehyde: Wood materials shall contain no added urea-formaldehyde.

C. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

D. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:

1. SPIB - Southern Pine Inspection Bureau.
2. WCLIB - West Coast Lumber Inspection Bureau.
3. WWPA - Western Wood Products Association.

E. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

F. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

1. Provide dressed lumber, S4S, unless otherwise indicated.
2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood blocking and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat items indicated on Drawings, and the following:

1. Framing for raised platforms.
2. Concealed blocking.
3. Roof framing and blocking.
4. Wood nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
5. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Furring.
5. Grounds.
6. Utility shelving.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:

1. Hem-fir (north); NLGA.
2. Mixed southern pine or southern pine; SPIB.
3. Spruce-pine-fir; NLGA.
4. Hem-fir; WCLIB or WWPA.
5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
6. Western woods; WCLIB or WWPA.
7. Northern species; NLGA.
8. Eastern softwoods; NeLMA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. General: Sheet products with graded face plies meeting DOC PS1 and US Product Standards PS 1-09. Provide sanded plywood

1. Bond Classification: “Exterior” for all plywood used at exterior or in exterior wall; “Exposure 1” for all other plywood ,
2. Core: Provide veneer core with no voids for electrical and communications backing boards.
3. Performance category value used as the nominal panel thickness.
4. Provide APA trademark and grading edgemarks and backstamps for all pieces. Provide stamp in location as required by authority having jurisdiction.

B. Communications and Electrical Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

C. Mirrored Glass Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch thick.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Screws for Fastening to Metal Framing: ASTM C 1002 length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 10 times the load imposed when installed in concrete as determined by testing per ASTM E488 conducted by a qualified independent testing and inspecting agency. Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E488 conducted by a qualified independent testing and inspecting agency. Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on [**ICC-ES AC01**] [**ICC-ES AC193**] as appropriate for the substrate.
1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2

2.7 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cleveland Steel Specialty Co.
2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.

4. Simpson Strong-Tie Co., Inc.
5. USP Structural Connectors.

B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

1. Use for interior locations unless otherwise indicated.

C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B; G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.

D. Stainless-Steel Sheet: ASTM A 666, Type 316.

1. Use for exterior locations and where indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

H. Where wood-preservative-treated lumber is installed adjacent to metal decking, cold-formed metal framing, aluminum sheet metal, galvanized coated steel, or coated carbon steel, install continuous flexible flashing separator between wood and metal decking.

I. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the Florida Building Code.
2. ICC-ES evaluation report for fastener.
3. FM Data Sheet 1-49.

J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 FIELD QUALITY CONTROL

A. Inspections: Exterior rough carpentry materials, fasteners, and installation related to the roof system, roof equipment supports and roof curbs are subject to observation and inspection for compliance with requirements by Commissioning Agent. Inspections may include but are not limited to the following:

1. Fastening schedule and metal connections.
2. Sealing penetrations.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 -- SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wall sheathing.
2. Exterior soffit boards.
3. Sheathing joint-and-penetration treatment.

B. Related Sections include the following:

1. Division 06 Section "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Division 07 Section "Fluid-Applied Air Barrier Membranes" for sheathing joint and penetration treatment.
3. Division 07 “Flexible Flashing” for openings in sheathing.
4. Division 09 “Exterior Painting” for painting exterior soffit boards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
2. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
5. Include fastening schedule for sheathing.

1.4 INFORMATION SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:

1. Fire-retardant-treated plywood.

1.5 QUALITY ASSURANCE

A. Source Limitations for Fire-Retardant-Treated Wood: Obtain each type of fire-retardant-treated wood product through one source from a single producer.

B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material from a qualified inspection agency that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

C. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing and inspecting agency acceptable to the Fire Marshal.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

1.7 SEQUENCING AND SCHEDULING

A. Sequence installing sheathing with installing exterior cladding to comply with requirements indicated below:

1. Do not leave glass-mat gypsum sheathing board exposed to weather for more than 180 days.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

A. Plywood: DOC PS 1 "Construction and Industrial Plywood" for wood structural panels.

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.2 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive

combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.

2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings.

2.3 WALL SHEATHING

A. Gypsum Wall Sheathing: ASTM C 1177/1177M.

B. Manufacturers and Product in compliance with requirements include:

1. (Basis of Design) G-P Gypsum Corporation; Dens-Glass Gold or equal.

C. Acceptable manufacturers: Subject to compliance with requirements, manufacturers and products that may be incorporated into the Work includes:
1. “Securock; USG
2. “GlasRoc Exterior Sheathing”, CertainTeed
3. “Weather Defense Platinum Sheathing”, fiberglass faced gypsum sheathing, Continental Building Products.

D. Type: Type X (fire rated) where indicated.

E. Thickness: As indicated.

1.1 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation, ProRoc Exterior Type X Soffit Board.
b. Georgia-Pacific Gypsum LLC, ToughRock Fireguard Soffit Board.
c. National Gypsum Company, Gold Brand Fire-Shield Exterior Soffit Board.
d. USG Corporation, Sheetrock Exterior Gypsum Ceiling Board, Firecode.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

B. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation, GlasRoc Sheathing.
b. Georgia-Pacific Gypsum LLC, DensGlass Fireguard Sheathing.
c. National Gypsum Company, Gold Bond eXP, Extended Exposure Sheathing.
d. USG Corporation, Securock Glass Mat Sheathing, Firecode.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

C. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

1. For steel framing less than 0.0329-inch thick, attach sheathing to comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112-inch thick, attach sheathing to comply with ASTM C 954.

2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Silicone Emulsion Sealant for Glass-Mat Gypsum Sheathing: Product complying with ASTM C 834, compatible with sheathing tape and gypsum sheathing, recommended by sheathing and tape manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

B. Glass-Fiber Sheathing Tape for Glass-Mat Gypsum Sheathing: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads per inch, of type recommended by sheathing

and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing board.

2.6 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.
2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.

C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8-inches o.c. and set back a minimum of 3/8-inch from edges and ends of boards.

1.2 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

3.3 SHEATHING JOINT-AND-PENETRATION TREATMENT

A. Refer to Division 07 “Fluid-Applied Air Barrier Membranes” for requirements.

END OF SECTION 061000

SECTION 062023 -- INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes interior finish carpentry.

B. Related Sections:

1. Division 06 “Interior Architectural Woodwork” for additional requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

1.4 QUALITY ASSURANCE

A. For Installers: Five years previous experience installing similar products in commercial offices.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

A. Materials and fabrication:

1. Conform to Architectural Woodwork Institute specifications for Custom quality work.

2.2 MATERIALS, GENERAL

A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.

1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
2. For exposed lumber, mark grade stamp on end or back of each piece.

B. Softwood Plywood: DOC PS 1.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and comply with testing requirements; testing will be conducted by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

C. For exposed items indicated to receive a stained or natural finish, use organic resin chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.

D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.

E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to Design Professional.

1. For exposed lumber indicated to receive a stained or natural finish, For exposed plywood indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

F. Application: All interior lumber and plywood.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

1. Use wood glue that has a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

1. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 48 hours.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32 inch maximum offset for flush installation and 1/16 inch maximum offset for reveal installation.
4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.5 CLEANING

A. Clean interior finish carpentry on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

A. Protect installed products from damage during remainder of the construction period.

END OF SECTION 062023

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Plastic-laminate cabinets.
2. Plastic-laminate countertops.
3. Wood base.

B. Related Sections include the following.

1. Division 01 Section "Sustainable Design Requirements."
2. Division 08 Section "Glazing" for glazing.
3. Division 09 “Interior Wall Paneling” for MDF paneling with laminate finish.
4. Division 12 “Solid Surface and Simulated Stone Countertops.”

C. Work specified elsewhere that is part of the work of this section includes, but is not necessarily limited to, applicable portions of the following:

1. Division 08 Section "Flush Wood Doors" for flush wood doors indicated to be attached to interior architectural woodwork.

D. Single Source Responsibility: Interior architectural woodwork includes interior glazing and stone countertops that are part of wood cabinets and desks, and are furnished and installed by the architectural woodwork manufacturer/installer.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items, unless concealed within other construction before woodwork installation.

B. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches above floor, and surfaces visible in open cabinets.

C. Semi-exposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches or more above floor are defined as semi-exposed.

D. Concealed Portions of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

1.4 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

A. Certify that all veneer wood products and 50 percent of all other wood products used for interior architectural woodwork originates from sustainably managed forests certified by one or more independent certification organization accredited by the Forest Stewardship Council (FSC)

B. Chemically treated wood shall not contain arsenic or its compounds.

C. Do not use wood species listed by CITES (Convention on International Trade in Endangered Species) for any interior architectural woodwork.

D. Adhere wood veneer or plastic laminate to substrate for all interior architectural woodwork using adhesive that complies with VOC (volatile organic compound) requirements defined in Division 1 Section “Environmental Impact of Materials.”

E. Finish all interior architectural woodwork with stains and/or transparent finishes that comply with VOC (volatile organic compound) requirements defined in Division 9 Section “Painting.”

F. Where adhesive is used in installation of interior architectural woodwork, provide adhesive that complies with USGBC guidelines for low VOC (volatile organic compounds).

G. Provide substrate for all interior architectural woodwork that complies with USGBC guidelines for low VOC (volatile organic compounds).

H. Provide substrate for all interior architectural woodwork that is manufactured without formaldehyde-based binding resin.

I. Collect and transport all recyclable scrap material in accordance with requirements of Division 1 Section “Construction Waste Management and Recycling.”

1.5 ACTION SUBMITTALS

A. Product Data: For hardboard, medium-density fiberboard, plywood, high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, and finishing materials and processes.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, and other items installed in architectural woodwork.

C. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.

1. Plastic laminates.
2. Thermoset decorative overlays.
3. Solid-surfacing materials.

D. Samples for Verification: For the following:

1. Lumber with or for transparent finish, 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
2. Plastic-laminate-clad panel products, 8 by 10 inches, for each type, color, pattern, and surface finish, with separate samples of unfaced panel product used for core.
3. Thermoset decorative-overlay surfaced panel products, 8 by 10 inches, for each type, color, pattern, and surface finish.
4. Solid-surfacing materials, 6 inches square.
5. Corner pieces as follows:

   a. Cabinet front frame joints between stiles and rail, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
   b. Miter joints for standing trim.

6. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.6 INFORMATION SUBMITTALS

A. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.7 QUALITY ASSURANCE

A. Single-Source Manufacturing and Installation Responsibility: Qualified Manufacturer to assume undivided responsibility for woodwork specified in this section, including fabrication, finishing, and installation. The manufacturer shall have had a minimum of 15 years successful experience in the custom fabrication and installation of architectural woodwork comparable to that shown and specified, be a member of the AWI, maintain an organized quality control program, perform its own in-house veneer lay-up work, and who retains facilities with sufficient capacity and quality to produce the required architectural woodwork without causing delay to the project.

B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.

1. Cabinet work: Material and fabrication shall conform to Architectural Woodwork Institute specifications for Custom quality work.

2. Cabinet hardware: it is preferred that hardware for cabinet work be furnished and installed by the installer of cabinetry.
3. Provide AWI Quality Certification Program certificate indicating that woodwork complies with requirements of grades specified.

C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

D. First Installed Work Mockups: Before fabricating and installing interior architectural woodwork, build mockups in place for each form of construction and finish required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups on the location and of the size indicated or, if not indicated, as directed by Design Professional.
2. Notify Design Professional seven days in advance of dates and times when mockups will be fabricated and installed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Design Professional's approval of mockups before starting interior architectural woodwork fabrication.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.

E. Pre-installation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.10 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Medium Density Fiberboard:

1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130, minimum 48 lbs/ cu. ft. density, minimum 3/4 inch thick, edged and faced as specified, fabricated with binder containing no urea formaldehyde, except with the following minimum physical properties:

   a. Modulus of Rupture: 4,496 psi.
   b. Modulus of elasticity: 449,600 psi.
   c. Screw-Holding on Face: 298 lbs.
   d. Screw-Holding on Edge: 225 lbs.

C. Lumber Standards: Comply with applicable provisions for grading and workmanship of AWI Quality Standards, Sections 100-S-1, 100-S-4, 100-S-5, Grade I and the requirements shown and specified, where standards conflict the more stringent shall apply. Provide lumber surfaced 4 sides (S4S) and fabricated to profiles shown. All lumber shall be kiln dried to the moisture content indicated in AWI Section 100-S-11.

1. Furring, Blocking, Shims: No. 1 Common; Southern Pine or Douglas Fir.
2. Solid Hardwood for Transparent Finish: Maple matching Design Professional's sample.
3. Solid Hardwood for Opaque Finish: Yellow Poplar, plain sawn, free from checks, splits, sound knots.

D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.

1. Manufacturers providing products in compliance with requirements include the following or equal:

   a. Formica
   b. Pionite
   c. Wilsonart

2. Colors and Textures: As indicated in the Interior Finish Legend.

E. Adhesives: Use only low emitting, zero formaldehyde crosslinked polyvinyl acetate (PVA) type adhesives which leave no glue lines on finished surfaces of architectural woodwork. Cross linked PVA adhesives shall be specifically compounded with a high pH catalyst level and for

cure speeds suitable for the use specified without the appearance of "Pinking" on natural finished architectural woodwork items.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article and with fire-test-response characteristics specified.

1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:

1. Interior Type A: Low-hygroscopic formulation.
2. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
3. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
4. Kiln-dry materials before and after treatment to levels required for untreated materials.

2.3 CABINET HARDWARE AND ACCESSORIES

A. NOTE: Hardware for cabinetwork shall be furnished and installed by the installer of cabinetry. Comply with ANSI/BHMA A156.9,"American National Standards for Cabinet Hardware." Use AWI standards for hinges.

B. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Door Hardware."

C. Hardware Standard: Comply with BHMA A156.9 for items indicated by referencing BHMA numbers or items referenced to this standard.

D. Frameless Concealed Hinges (European Type) for Cabinet Doors: BHMA A156.9, B01602, 170 degrees of opening, self-closing. Provide bright nickel finish (US 15).

E. Wire Pulls for Drawers: Back mounted, 4 inches long, 5/16 inches in diameter, and 1-1/4 inch projection. Provide satin finished chrome plated brass or bronze (US26D), or stainless steel with satin finish (U32D).

1. (Basis of Design) Mockett DP 129 or equal unless otherwise noted.

2. At entry lobby reception desk and as noted provide Richelieu Contemporary Metal handle Pull 8071 or equal. Refer to millwork drawings for product number and finish.

F. Silencers for Cabinet Doors: Provide felt silencers on jamb, head, and sill strike areas of all cabinet doors; 2 for paired doors, 3 for single doors.

G. Adjustable Shelf Standards and Supports for Heavy Duty Shelves: BHMA A156.9, B04102; with shelf brackets, B04112. Provide anochrome on heavy duty steel finish.

1. Provide blocking in wall or furring to support loads.
2. Oversized Standard and Bracket System.

a. Provide blocking in wall or furring to support loads.

b. Standards and brackets: up to 460 lbs/pair.
1) Single slot design.
2) Adjustable in 1" increments.
3) (Brackets) 16-Gauge Steel Construction with Anochrome (ANO) finish.
4) (Standards) 14-gauge steel construction.

H. Shelf Rests for Base and Wall Cabinets: BHMA A156.9, B04013. Provide nickel plated or anochrome plated brass finish.

I. Drawer Slides: Side-mounted, full-extension, zinc-plated steel drawer slides with steel ball bearings, BHMA A156.9, B05091, and rated for the following loads:

1. Pencil Drawer Slides: 45 lbf. Capacity medium duty load rating, 3/4 extension carburized steel ball bearing, side mounting, cold rolled steel slide members and ball retainers, cushioned in and outstops, single movement action, positive stop, bright electro zinc plate finish.
2. Keyboard Slide: 75 lbf. Capacity medium duty load rating, full extension carburized steel ball bearing, cold rolled steel slide members and ball retainers, secure in partial or fully extended position, adjustable keyboard platform, black powder-coated finish.
3. Box Drawer Slides Less Than 4 Inches Deep: 75 lbf. Capacity medium duty load rating, full extension carburized steel ball bearing, side mounting, cold rolled steel slide members and ball retainers, cushioned in and outstops, detent-in, progressive action, positive stop, bright electro zinc plate finish.
4. Box Drawer Slides Greater Than 4 inches but Less Than 8 Inches Deep: 100 lbf. Capacity medium duty load rating, full extension carburized steel ball bearing, side mounting, cold rolled steel slide members and ball retainers, cushioned in and outstops, detent-in, progressive action, positive stop, bright electro zinc plate finish.
5. File Drawer Slides 8 Inches Deep or More: 150 lbf. Capacity heavy duty load rating, full extension carburized steel ball bearing, rail mounting, cold rolled steel slide members and ball retainers, cushioned in and outstops, detent-in, progressive action, positive stop, bright electro zinc plate finish.
6. Trash Bin Slides: 200 lbf. Capacity heavy duty load rating, full extension carburized steel ball bearing, side mounting, cold rolled steel slide members and ball retainers, cushioned in and outstops, detent-in, progressive action, positive stop, bright electro zinc plate finish.

J. Door Locks: BHMA A156.11, E07121. Provide bright chromium plated brass or bronze finish.

K. Drawer Locks: BHMA A156.11, E07041. Provide bright chromium plated brass or bronze finish.

L. Grommets for Cable Passage through Countertops: 2-1/2 inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color to be selected by Design Professional.

M. Coat Rods: Provide where shown, including accessories.

1. Tubing: Outside diameter 1-1/2 inch unless otherwise shown. Steel with polished chrome finish.
2. End Flanges: To match diameter of tubing.
3. Cup Adapter Center Hanger: Provide adapter to suit diameter of tubing.

N. Hanging (Zee Clip) Strips: Extruded aluminum zee type interlocking clips; type, size and quantity for the condition of use.

O. Stainless Steel Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.

P. Stainless Steel Bars and Shapes: ASTM A 276, Type 304.

2.4 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: Comply with AWI Section 400 and 400C requirements for high-pressure decorative laminate countertops.

B. Grade: Custom.

C. High-Pressure Decorative Laminate Grade: HGS.

D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. Match color, pattern, and finish as indicated by manufacturer's designations for these characteristics in the Interior Finish Legend.

E. Edge Treatment: Same as laminate cladding on horizontal surfaces, applied before face sheets are applied.

F. Backing Sheets: Nondecorative, grade types and thickness to match face sheets and equalize pull.

G. Core Material: Medium density fiberboard.

2.5 PLASTIC-LAMINATE CABINETS

A. Quality Standard: Comply with AWI Section 400 and 400B requirements for laminate cabinets.

B. Grade: Custom.

C. AWI Type of Cabinet Construction: Flush overlay.

D. Reveal Dimension: 1/2 inch unless otherwise indicated.

E. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

1. Horizontal Surfaces Other Than Tops: HGS.
2. Postformed Surfaces: HGP.
3. Vertical Surfaces: HGS.
4. Edges: HGS, applied before face sheets are applied.
5. Backing Sheets: Nondecorative, grade types and thickness to match face sheets and equalize pull.

F. Materials for Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate.
2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

G. Adjustable Shelving: Section 400A-S-8 Custom Grade for multiple holes with peg spacing at 1 inch o.c.

H. Core Material: Medium density fiberboard or medium density particleboard.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. Match color, pattern, and finish as indicated by laminate manufacturer's designations for these characteristics in the Interior Finish Legend.

2.6 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 300.

B. Wood Species: See Finish Schedule and Legend.

C. Finish: Stained and clear finished to match Design Professional’s sample.

1. Stain Color: To be selected by the Design Professional.

2.7 WOOD CABINETS (CASEWORK) FOR TRANSPARENT FINISH

A. Quality Standard: Comply with AWI Section 400 and 400A requirements for wood cabinets.

B. Grade: Premium, with Grade AA faces.

C. AWI Type of Cabinet Construction: Flush overlay.

1. Route fingerpulls into continuous hardwood strip dado and inset into cabinet door edges.

D. Reveal Dimension: 1/2 inch unless indicated otherwise.

E. Wood Species and Cut for Exposed Surfaces: Maple matching Design Professional's sample.

1. Grain Matching: Run and match grain vertically for drawer fronts, doors, and fixed panels, unless indicated otherwise.
2. Matching of Veneer Leaves: Book match.
3. Vertical Matching of Veneer Leaves: End match.
4. Veneer Matching within Panel Face: Balance and center match.

F. Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Match species and cut indicated for exposed surfaces.
2. Drawer Sides and Backs: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
3. Drawer Bottoms: Hardwood plywood stained to match species indicated for exposed surfaces.

G. Edge Treatment of Doors: Section 400A-S-2 and 400-A-S-3, Premium Grade.

H. Adjustable Shelving: Section 400A-S-8 Custom Grade for multiple holes with peg spacing at 1 inch o.c.

I. Core Material: Medium density fiberboard or medium density particleboard.

2.8 FASTENERS, ANCHORS, AND MISCELLANEOUS MATERIALS

A. Screws: Select material, type, size, and finish required for each use. Comply with FS FF-S-111 for applicable requirements. For metal framing supports, provide screws as recommended by metal framing manufacturer.

B. Nails: Select material, type, size, and finish required for each use. Comply with FS FF-N-105 for applicable requirements.

C. Anchors: Select material, type, size, and finish required by each substrate for secure anchorage. Provide toothed steel or lead expansion bolt devices for drilled-in-place anchors.

D. Clips: Select material, type, size, and finish required by each substrate for secure anchorage.

E. Blind Splines and Draw Downs: Specialty devices, as required for tight butt joining, types and size as recommended by woodwork fabricator.

F. Covercaps: Where mortises of fastener heads, or draw downs are exposed (blind holes) in finished work, provide black plastic covercaps.

2.9 SHOP FINISHING

A. Quality Standard: Comply with AWI Section 1500, unless otherwise indicated.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative overlay.
2. Gluing of face veneers shall, where possible, be by the hot plate method; glued surfaces shall be in close contact throughout. Glue stains will not be permitted.
3. Grain of all transparent finished wood shall run in the direction shown, or if not shown, as accepted on the shop drawings.

D. Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, and sheen, with sheen measured on 60-degree gloss meter per ASTM D 523:

1. Grade: Premium.
2. AWI Finish System TR-2: Catalyzed lacquer.
3. Staining: Color to match Design Professional’s sample as indicated in the Interior Finish Legend.
4. Effect: Partially filled pore.
5. Sheen: Satin, 30-50 gloss units.

E. Opaque Finish: Field primed and painted. Refer to Division 09 Section "Interior Painting."

2.10 METAL FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Quality Standard: Install woodwork to comply with AWI Section 1700.

B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.

F. Countertops: Anchor securely.

1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Secure backsplashes to tops.
3. Seal space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base, if finished.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork, including countertops, on exposed and semi-exposed surfaces.

END OF SECTION 064023

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Modified bituminous sheet waterproofing for concrete slabs.

2. Foundation drainage board and protection course.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. D 5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes (laboratory only).
2. E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

1.4 PERFORMANCE REQUIREMENTS

A. Provide waterproofing that prevents the passage of water.

1.5 SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing as may be required to show compliance with the Contract Documents.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Show installation details for termination conditions at grade and at other waterproofing systems.
2. Show installation details for inside and outside corners.

C. Samples: For the following products:

1. 12-by-12-inch square of waterproofing and flashing sheet.

2. 4-by-4-inch square of drainage panel.

D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

E. Installer Qualifications: Submit Installer's experience resume demonstrating the Installer's capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information as requested or specified.

F. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.

G. Manufacturer’s Review of Waterproofing: Before purchasing and delivering waterproofing materials to the project site, submit written statement signed by the Contractor and Installer, stating that the drawings and specifications for waterproofing work have been reviewed with a qualified representative of each of the selected manufacturers of the waterproofing materials, and that the manufacturers have not indicated any further precautions or additional requirements to be fulfilled in connection with the use of the selected materials on this project, and that the selected materials, conditions and details are not in conflict with the waterproofing manufacturer's warranty. Distribute one copy of statement to the waterproofing manufacturer.

H. Inspection Report for Information: Copy of waterproofing system manufacturer's inspection reports of waterproofing work.

I. Warranty: Copy of special waterproofing Manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer, recognized and approved by the specified waterproofing manufacturer, who has completed a minimum of three waterproofing membrane applications over the last five years which were similar in material, design, and extent to that indicated for the Project, as determined by the Design Professional, and which have resulted in construction with a record of successful in-service performance. Provide project names, locations, completion dates, names and telephone numbers of each project's architect and owner.
   1. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the work. The Installer shall maintain a full time supervisor/foreman who is on job site during times that waterproofing work is in progress and who is experienced in installing waterproofing systems similar to type and scope required for this Project.

B. Manufacturers Qualifications: Minimum of 5 years successful experience completing projects which were similar in material, design, and extent to that indicated for the Project.

C. Source Limitations: Obtain waterproofing materials and molded-sheet drainage panels through one source from a single manufacturer.

D. Manufacturer’s Inspection: Contractor shall arrange and pay for the manufacturer of the self-adhering sheet waterproofing to inspect, test and report all work pertaining thereto. The Contractor shall arrange for the manufacturer to perform the above duties for the full duration of

the waterproofing work. The Contractor shall be responsible for carrying out all recommendations of the Manufacturer to ensure a total and complete installation of waterproofing work. The issuance of the Manufacturer's final inspection report shall be made prior to the acceptance of the work by the Architect.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

F. First Installed Work Mockups: Apply mockups to set quality standards for materials and execution.

1. Testing and Inspection: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation; membrane application, flashings, protection, and drainage components, prior to backfilling.
2. Provide written report stating that installation complies with manufacturer's written instructions.
3. Select one representative surface for application of self-adhered waterproofing at least 200 SF. to demonstrate surface preparation, joint and crack treatment, and standard of workmanship.
4. Approved mockups may become part of the completed Work if undisturbed at time of Material Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Store rolls according to manufacturer's written instructions.

E. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp, wet, or frost covered substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.9 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight during specified warranty period.

1. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate exceeding 1/16-inch in width.

2. Warranty Period: Five years after date of Material Completion.

B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: 60-mil- thick, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil- thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner.

B. Source Limitations: Contractor to provide self-adhering sheet waterproofing materials and products with proven compatibility with Fluid-Applied Membrane Air Barriers. Refer to Division 07 “Fluid-Applied Membrane Air Barriers" for additional requirements.

1. Manufacturers providing comparable products in compliance with requirements include the following:

   a. American Hydrotech, Inc; VM75.
   b. GCP Applied Technologies.; Bituthene 3000.
   c. Henry Company; Blueskin WP 200.

2. Physical Properties:

   a. Tensile Strength: 250 psi minimum; ASTM D 412.
   b. Ultimate Elongation: 300 percent minimum; ASTM D 412.
   c. Vapor Permeance: 0.05 perms; ASTM E 96, Water Method.
   d. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
   e. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
   f. Puncture Resistance: 40-lbf minimum; ASTM E 154.
   g. Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.
   h. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of sheet waterproofing material.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.

E. Sealant: as recommended by manufacturer for application. Refer to Division 07 Section “Joint Sealants” for additional requirements.

F. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.

G. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.

H. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

1. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2-inches wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.

I. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8-inch thick, predrilled at 9-inch centers.

J. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

1. Thickness: 1/8-inch, nominal, for vertical applications; 1/4-inch, nominal, elsewhere.

2. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.

2.3 MOLDED-SHEET DRAINAGE PANELS

A. Molded-Sheet Drainage Panel: Prefabricated, composite drainage panels, manufactured with a permeable geotextile facing laminated to a molded-plastic-sheet drainage core.

1. Drainage Core: Three-dimensional, nonbiodegradable, molded-plastic-sheet material designed to effectively drain water under backfill pressure; complying with the following properties determined according to tests indicated:

a. Compressive Strength: 18,000 lbf/sq. ft., minimum; ASTM D 1621.
b. Flow Rate: 15 gpm per ft., minimum, at hydraulic gradient of 1.0 and compressive stress of 25 psi; ASTM D 4716.

2. Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:

a. Survivability: Class 2.

b. Apparent Opening Size: No. 70 sieve, maximum.
c. Permittivity: 0.1 per second, minimum.

3. Film Backing: Polymeric film bonded to drainage core surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
3. Verify that lean concrete working slab (mud slab) substrate is dry, smooth, and sound; and ready to receive adhesive-coated HDPE sheet.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates according to manufacturer's written instructions. Remove dust and dirt from joints and cracks according to ASTM D 4258 and manufacturer's written instructions.

1. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16-inch.

F. Bridge and cover isolation joints with overlapping sheet strips.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135 and manufacturer's written instructions.

H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135 and manufacturer's written instructions.

3.3 MODIFIED BITUMINOUS SHEET WATERPROOFING APPLICATION

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.

D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.

E. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.

F. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.

G. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic.

H. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.

I. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.

J. Install protection course with butted joints over waterproofing membrane immediately.

K. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

3.4 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.5 FIELD QUALITY CONTROL

A. Inspection: Engage a full-time manufacturer's representative to inspect substrate conditions; surface preparation; membrane application, flashings, and protection; and to furnish daily reports to Architect. Manufacturer's representative shall provide a written report that the completed installation complies with manufacturer's written instructions.

1. Remove and replace applications of self-adhering sheet waterproofing where inspection indicates that it does not comply with specified requirements.

B. Perform additional inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.6 PROTECTION AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071326

SECTION 071616 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide the Work of this Section in accordance with Requirements of the Contract Documents.

B. This Section includes but is not limited to

1. Crystalline waterproofing for application on inside walls of elevator pits, sump pits and elsewhere as shown.

C. Related Work:

1. Division 03 Section "Cast-in-Place Concrete" for the finishing of concrete walls and slabs to receive waterproofing.
2. Division 04 Section "Unit Masonry" for construction cleaning of concrete unit masonry walls to receive waterproofing.
3. Division 07 Section "Sheet Membrane Waterproofing" for other waterproofing systems.
4. Division 07 Section "Joint Sealants" for elastomeric and preformed sealants in concrete and concrete unit masonry walls and floors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, substrate preparation, and installation instructions.

B. Shop Drawings: Show locations and details of waterproofing preparation and application. Show expansion joint details and waterproofing application at obstructions and penetrations.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Applicator.

B. Product Certificates: For each type of waterproofing, patching, and plugging material.

C. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm approved by the manufacturer with a minimum of 5 year successful experience in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical vertical and horizontal surfaces 10 sq. ft. in size, unless otherwise shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions.

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F or above during work and cure period, and space is well ventilated and kept free of water.

1.8 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by the Applicator and countersigned by the Contractor agreeing to repair or replace waterproofing material that does not comply with requirements or that fails to perform as required, and to maintain watertight conditions within specified warranty period. Warranty includes responsibility for removing and replacing other work that conceals crystalline waterproofing. During warranty period, repairs and replacements required because of unusual weather phenomena and other events beyond Contractor's or Applicator's control shall be completed by Contractor or Applicator and paid for by Owner at prevailing rates.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Sole Source Responsibility: Obtain crystalline Waterproofing from one source of a single manufacturer. Obtain compatible patching and plugging compounds from the manufacturer or from sources acceptable to the manufacturer. Where crystalline waterproofing interfaces with other waterproofing systems, provide compatible systems to ensure continuity of waterproofing at transition details. Follow manufacturer's details and technical notes regarding detailing required at these transitions.

2.2 WATERPROOFING MATERIALS

A. Crystalline Waterproofing: Prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties complying with or exceeding the criteria specified below.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. American PERMAQUIK Inc; Super 200.
   b. AQUAFIN, Inc; AQUAFIN-1C.
   c. BASF Corporation; Construction Systems; MasterSeal 500 (Pre-2014: Tegraproof).
   d. Conproco Corporation; Conpro Super Seal.
   e. Euclid Chemical Company (The); an RPM company; HEY'DI K-11.
   f. Gemite Products Inc.; Cem-Kote CW Plus.
   g. ICS Penetron International Ltd; Penetron.
   h. Vandex USA LLC; Vandex Super/Super White.
   i. Xypex Chemical Corporation; Xypex.
   j. Kryton Smart Concrete; Krystol T1.

2. Water Permeability: Maximum zero for water at 30 feet when tested according to COE CRD-C 48.
3. Compressive Strength: Minimum 4000 psi at 28 days when tested according to ASTM C109.

2.3 ACCESSORY MATERIALS

A. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

B. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AQUAFIN, Inc.; Fix 10-S or Mortar-1C.
b. Gemite Products, Inc.; Gem-Plast TC, Fiber-Patch OV, or Fiber-Patch WP
c. Specon, Incorporated; Hydrocel (HCMM).
d. Euclid Tamms Industries, Inc.; Hey'Di Powder-X System.
e. ThoRoc, Div. of ChemRex; Tegraproof mortar.

C. Portland Cement: ASTM C 150, Type I.

D. Sand: ASTM C 144.

E. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and not to create a vapor barrier.

F. Water: Potable.

2.4 MIXES

A. Crystalline Waterproofing: Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.

B. Protective Topping: Measure, batch, and mix Portland cement and sand in the proportion of 1:3 and water. Blend together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.

C. Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance to manufacturer’s product data.

D. Substrate Acceptance: Proceed with application only after unsatisfactory conditions have been corrected. Commencement of crystalline waterproofing application, constitutes substrate acceptance.

E. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for preparation of substrates.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. Remove fins, ridges, and other projections.

2. At holes and cracks 1/16 inch wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces according to ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution according to ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning according to ASTM D4259.

2. Clean concrete unit masonry surfaces according to ASTM D4261.

a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch.

3. Concrete Joints: Clean reveals.

3.3 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

a. Onto columns integral with treated walls.
b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches for cast-in-place concrete and 48 inches for masonry.
c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches, where floors, but not walls, are treated.
d. Onto every substrate in areas indicated for treatment, including pipe trenches pipe chases pits sumps and similar offsets and features.

e. Interface with Other Materials: Extend cementitious crystalline water proofing 6 inches minimum beyond interface with other waterproofing systems.

3. Number of Coats: Number required for specified water permeability.
4. Application Method: Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
5. Dampen surface between coats.

B. Final Coat Finish: Smooth.

C. Curing: Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.

D. Protective Topping: Apply 1-inch- thick, protective topping over floor surfaces.

3.4 FIELD QUALITY CONTROL

A. Inspection: Engage a manufacturer-authorized field service representative to test and inspect substrate conditions, initial application and completed application of waterproofing.

1. Prepare test and inspection reports, and furnish to Architect.

END OF SECTION 071616

SECTION 071710 – BENTONITE AND HYDROPHILIC WATERSTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes bentonite and hydrophilic waterstops.

B. Related Sections include the following:

1. Division 03 Section "Cast-In-Place Concrete."
2. Division 07 Section “Sheet Waterproofing.”

C. NOTE: Waterstops and sheet waterproofing to be compatible and provided from a single manufacturer.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions. Include manufacturer’s written instructions for evaluating, preparing and treating substrate.

B. Shop Drawings: Include details for waterstops at concrete foundation wall construction joints, block-outs, and wall penetrations, including sleeves.

1. Show installation details indicating minimum concrete cover for waterstops and position of steel reinforcing bars.

C. Samples: For each of the following products, in sizes indicated:

1. Waterstops: 12 inches long.

D. Material Certificates: For bentonite and hydrophilic waterstops.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain waterstops and adhesives through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.

B. Store materials in a dry, well-ventilated space.

C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterstops to be installed according to manufacturers' written instructions and warranty requirements.

1. Do not apply waterstops to surfaces where ice or frost is visible. Do not apply bentonite waterstops in areas with standing water.

2. Placing of bentonite waterstops on damp surfaces is allowed if approved in writing by manufacturer.

PART 2 - PRODUCTS

2.1 BENTONITE WATERSTOPS

A. Preformed Bentonite Waterstops: Flexible strips of bentonite waterproofing compound in coil form; designed specifically for vertical and horizontal joints in concrete construction. Waterstop material shall consist of 75 percent sodium bentonite and 25 percent butyl rubber compound, and shall be a nominal 1 inch by 3/4 inch extruded rectangular shape.

B. Products: Provide one of the following or equal:

1. Carlisle Coatings & Waterproofing Incorporated; CCW MiraSTOP.
2. (Basis of Design) CETCO; Volclay Waterstop-RX-101.
3. Greenstreak; Swellstop.

2.2 HYDROPHILIC WATERSTOPS

A. Preformed Hydrophilic Waterstops: Flexible strips of hydrophilic waterproofing compound in coil form; designed specifically for vertical and horizontal joints in concrete construction. Waterstop material shall consist of polyurethane and butyl rubber based material free of sodium bentonite, and shall be a nominal 1 inch by 1/2 inch extruded rectangular shape.

B. Products: Provide one of the following or equal:

1. CETCO; Akwastop™ Hydrophilic Rubber Waterstop.
2. (Basis of Design) Grace; Adcor™ ES Hydrophylic Waterstop.
3. Henry; HF302- Hydro-Flex Waterstop.

2.3 INSTALLATION ACCESSORIES

A. Adhesive for Bentonite Waterstops: Bentonite waterstop manufacturer’s recommended non-flammable, latex, water-based adhesive specially formulated to work with bentonite waterstops.

1. Products:

   a. Carlisle Coatings & Waterproofing Incorporated; CCW-702 or CCW AWP Primer.
   b. Colloid Environmental Technologies Company; Volclay WB-Adhesive.
   c. Greenstreak; Swellstop Primer Adhesive.

B. Adhesive for Hydrophilic Waterstops: Hydrophilic waterstop manufacturer's recommended non-flammable, latex, water-based adhesive specially formulated to work with hydrophilic waterstops.

C. Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of waterstops.

1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate work in the vicinity of waterstops to ensure proper conditions for installing the waterstops.

B. Clean substrate according to manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

A. Install waterstops and accessories according to manufacturer's written instructions, standard details, and recommended practices. Consult with manufacturer where any special conditions not otherwise covered in printed instructions occur.

B. Provide hydrophilic waterstops at locations waterproofed with self-adhering sheet waterproofing. Refer to Division 07 Section "Self-Adhering Sheet Waterproofing."

3.4 WATERSTOP INSTALLATION

A. Application: Install waterstops after installation of reinforcing bars, but prior to placing of interior forms and pouring of concrete. Secure waterstops to substrate with manufacturer's recommended adhesive. Mechanical fasteners may be used in conjunction with adhesive.

1. End Joints: Place in maximum practicable lengths to minimize coil end joints. Tightly butt coil ends to form a continuous waterstop. Do not overlap coil ends.

2. Concrete Cover: Place waterstops so that they will be encapsulated with at least 3 inches of concrete on all sides.

B. Static Construction Joints: Install waterstops in all vertical and horizontal construction pour joints in concrete foundation walls and on concrete footings.

C. Sleeved Pipe and Conduit Penetrations: Install waterstop strip around outer diameter of the sleeve. Install another waterstop strip between the sleeve's inner diameter and the pipe or conduit, contacting both surfaces continuously. Completely fill the void area between the sleeve and pipe, or conduit, with non-shrink grout.

D. Pipe and Conduit Penetrations: Install waterstop strip around outer diameter of the pipe and conduit.

E. Protection: Protect waterstops from damage and wetting prior to and during subsequent construction operations.

END OF SECTION 071710

SECTION 072100 - THERMAL AND SOUND ATTENUATION INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes but is not limited to:

1. Foam-plastic board insulation.
2. Mineral-wool board insulation
3. Glass-fiber blanket insulation.
4. Spray Foam Insulation
5. High Performance Blanket Insulation.

B. This Section includes the following insulation uses:

1. Perimeter insulation under slabs-on-grade.
2. Perimeter wall insulation (supporting backfill).
3. Cavity-wall insulation.
4. Curtain Wall insulation at Spandrel Glazing.
5. Concealed building insulation.
6. Sound attenuation insulation.

C. Related Sections:

1. Division 06, Section "Sheathing" for board sheathing over steel framing.
2. Division 07 “Under Slab Vapor Retarder.”
3. Division 07, Sections “Thermoplastic–Polyolefin (TPO) Roofing" “KEE Roofing” and “Fluid-Applied Roofing” for insulation specified as part of roofing construction.
4. Division 7, Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
5. Division 09 “Gypsum Board Assemblies” for additional requirements.
6. Division 22 Section "Plumbing Insulation."
7. Division 23 Section "HVAC Insulation."

1.3 DEFINITIONS

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.4 PERFORMANCE REQUIREMENTS

A. Insulation materials shall comply with the Florida Building Code and ASHRAE 90.1.

B. Additional insulation or improved thermal performance materials and systems may be required to achieve energy efficiency goals associated with LEED certification requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 INFORMATION SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E 84.
2. Fire-Resistance Ratings: ASTM E 119.
3. Combustion Characteristics: ASTM E 136.

C. Recycled Content: Provide glass and slag-wool-fiber/rock-wool-fiber insulation with recycled content so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following percent:

1. Glass Fiber Insulation: 25 percent.
2. Slag-Wool-Fiber/Rock-Wool-Fiber Insulation: 75 percent.

D. First-Installed Work Mockups: Prior to installing exterior wall systems, construct exterior wall thermal insulation Incorporate each type of exterior wall construction and finish to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution.

1. Provide thermal insulation, fire safing, spandrel insulation for incorporation in composite curtain wall assembly.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Design Professional specifically approves such deviations in writing.
3. Approved mockups shall become part of completed work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install insulation during inclement weather or when surfaces are moist.

B. Do not install fiberglass batt insulation in exterior wall assemblies until exterior sheathing has been installed and joints sealed in accordance with Division 07 Section "Sheathing", and air barrier has been fully applied to exterior face of sheathing in accordance with applicable Division 07 Section.

1. Insulation that is exposed to moisture due to inadequate or compromised environmental protections, or that becomes wet or moist by other means subsequent to installation, shall be completely removed and discarded, and replaced with new materials.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Formaldehyde Free: Provide formaldehyde-free products, or low emitting products when tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.2 CAVITY WALL RIGID INSULATION

A. Extruded-Polystyrene Board Insulation: Rigid, cellular, polystyrene thermal insulation with closed cells and integral high-density skin; formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV.

1. Adhesive: Type recommended by insulation board manufacturer for application indicated.

B. Subject to compliance with requirements, provide products by the following manufacturers:

1. Dow Chemical Company or equal.
2. DiversiFoam Products.
3. Owens Corning.

C. Product and Manufacturer – Basis of Design: STYROFOAM Square Edge; Dow Chemical Company

1. Compressive Strength: Minimum 40 psi (ASTM D1621).
2. Water Absorption: Maximum 0.1% (ASTM C272)
3. Thermal Resistance (R Value): Minimum 10 for thickness indicated.

3. Compressive Strength: 25 psi minimum per ASTM D1621.
4. Thickness: 2 inches

2.3 CURTAIN WALL INSULATION

A. Basis-Of-Design Manufacturer/Product for Curtain Wall Insulation and Fire Safing:

1. Thermafiber, Glazed Curtain Wall Insulation meeting UL test assembly CW-S-2001 or equal, and as follows:

   a. Must meet ASTM E 2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using the Intermediate-Scale Multi-Story Test Apparatus.
2. Product:

   a. Thickness: 3 inches, R12.6
   b. Provide Insulation with black coating at translucent spandrel glass.
   c. Thickness For Mullion Covers: 2-inches.

2.4 SOUND ATTENUATION BLANKET INSULATION:

A. Manufacturers: Subject to compliance with requirements, provide insulation products by one of the following:

1. Batt and Sound Attenuation Blanket Insulation:

   a. CertainTeed Corporation.
   b. Knauf Fiber Glass GmbH.
   c. Owens-Corning Fiberglas Corporation.
   d. Schuller International, Inc.

2.5 GLASS-FIBER BLANKET INSULATION

A. Available Manufacturers:

1. CertainTeed Corporation.
2. Guardian Fiberglass, Inc.
3. Johns Manville.
4. Knauf Fiber Glass.
5. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:

1. 3-5/8 inches thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F.
2. 5-1/2 inches thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F.

2.6 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. BASF Corporation.
   b. Dow Chemical Company (The).
   c. Henry Company.

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.7 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

B. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Contact Adhesive: 250 g/L.

2.8 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Available Products:

   a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
   b. Eckel Industries of Canada; Stic-Klip Type N Fasteners.
   c. Gemco; Spindle Type.

2. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Available Products:

   a. Gemco; 90-Degree Insulation Hangers.

2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.

3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Available Products:

a. AGM Industries, Inc.; RC150.
b. AGM Industries, Inc.; SC150.
c. Gemco; Dome-Cap.
d. Gemco; R-150.
e. Gemco; S-150.

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

a. Ceiling plenums.
b. Where indicated.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.

1. Available Products:

a. Gemco; Clutch Clip.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

1. Available Products:

a. AGM Industries, Inc.; TACTOO Adhesive.
b. Eckel Industries of Canada; Stic-Klip Type S Adhesive.
c. Gemco; Tuff Bond Hanger Adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

C. Install semi-rigid board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

D. Install curtain wall insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

E. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..

1. Fill voids in the perimeter of the building shell whether or not indicated on the drawings. This includes space behind steel beams, channels, CMU, and miscellaneous framing.

3.5 INSTALLATION SPRAY FOAM INSULATION

A. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.6 INSTALLATION OF INSULATION IN PARTITION WALLS AND CEILINGS FOR SOUND ATTENUATION

A. Install 3-1/2-inch- thick, unfaced slag-wool-fiber/rock-wool-fiber blanket insulation over suspended ceilings at partitions in a width that extends insulation 24 inches on either side of partition.

B. Install 3-1/2-inch- thick, unfaced slag-wool-fiber/rock-wool-fiber blanket insulation from bottom plate to underside of deck at partitions indicated on contract documents to require sound attenuation.

3.7 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072710 – UNDER-SLAB VAPOR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Horizontal under-slab vapor barrier under concrete slabs.

B. Related sections:

1. Division 03 "Cast-in-Place Concrete" for concrete slabs.

1.3 PERFORMANCE REQUIREMENTS

A. Prepare substrate in accordance with ACI 302.1R Section 4.1 and manufacturer's written directions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Manufacturer's installation instructions for placement, seaming and pipe boot installation.

C. Shop Drawings: Show locations and extent of under-slab vapor barrier.

D. Samples for Verification: 12-by-12-inch square of vapor barrier.

1.5 INFORMATION SUBMITTALS

A. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

B. Qualification Data: For Installer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

1. Independent laboratory test results showing compliance with ASTM E 1745.

D. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is acceptable to vapor barrier manufacturer for installation of vapor barrier required for this Project.

B. Source Limitations: Obtain vapor barrier materials through one source from a single manufacturer.

C. Mockups: Before beginning installation, install under-slab vapor barrier to 100 sq. ft to demonstrate execution quality.

1. If Architect determines mockups do not comply with requirements, re-apply vapor barrier until mockups are approved.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing.

B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by vapor barrier manufacturer.

C. Store rolls according to manufacturer's written instructions.

D. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Apply vapor barrier within the range of ambient and substrate temperatures recommended by manufacturer.

1.9 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace vapor barrier material that does not comply with requirements.

PART 2 - PRODUCTS

2.1 PLASTIC UNDER-SLAB VAPOR BARRIER

A. Plastic Vapor Retarder: ASTM E 1745, Class A, and as follows:

1. Water Vapor Permeance: 0.020 perms maximum per ASTM F 1249 and ASTM E 96.
2. Thickness of Plastic Material: 15 mils, minimum.

B. Available Manufacturers and Products or equal:

1. Fortifiber Corporation; Moistop Ultra 15.
2. Meadows, W. R., Inc.; Perminator 15 Mil.
3. (Basis of Design) Stego Industries, LLC; Stego Wrap, 15-mil.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by vapor barrier manufacturer for intended use and compatible with sheet vapor barrier.

B. Manufacturer's sealing tape:

1. High Density Polyethylene Tape with pressure sensitive adhesive.
2. Minimum width 4-inches.

C. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

D. Pipe Flashing: Fabricate pipe flashing boots from vapor barrier material and pressure sensitive tape or mastic per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that compacted subgrade is ready to receive vapor barrier.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates in accordance with manufacturer's written instructions.

B. Clean substrates of substances harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.3 PLASTIC VAPOR RETARDER INSTALLATION

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

2. Extend vapor retarder to extremities of concrete slabs-on-grade scheduled to receive architectural floor finishes.

3. Lap vapor retarder over footings and seal to foundation walls.

B. Seal joints caused by pipes, conduits, and similar items penetrating vapor retarders with pipe flashing or mastic to create an airtight seal between penetrating objects and vapor retarder.

C. Repair tears or punctures in vapor retarders before concealment by other work. Cover with another layer of vapor retarder, overlapping damaged area 6 inches and taping all sides.

3.4 CONCRETE PLACEMENT

A. Place concrete within 30 days. Inspect membrane and repair any damage with patches of tape. Ensure all liner is removed from membrane and tape before placing concrete.

3.5 PROTECTION AND CLEANING

A. Protect installed vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072710

SECTION 072713 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Self-adhering, vapor-retarding, modified bituminous sheet air barriers.

B. Related sections:

1. Division 06 Section "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
2. Division 07 “Flexible Flashing” for flashing at penetrations and through wall flashing.

1.3 REFERENCES

A. ASTM E2178 Standard Test Method for Air Permeance of Building Materials.

B. ASTM E 2357 Test Method for Determining Air Leakage of Air Barrier Assemblies.

C. ASTM E 1186 – 03: Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

D. Conduct air barrier adhesion testing in accordance with ASTM D 4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

1.4 DEFINITIONS

A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.5 PERFORMANCE REQUIREMENTS

A. Provide air barrier membranes constructed to perform as continuous vapor permeable air barrier membranes and water barriers, which are flashed to drain water to the exterior. Air barrier membranes shall accommodate building material movements with expansion and control joints and accessory air barrier materials.

B. Air Barrier membranes shall be non-combustible and compatible with transition membranes, sealants, self-adhered membrane flashing and other transition material to provide complete system.

C. Air Barriers and accessory materials shall be rated for a UV exposure of not less than 90 days.

D. Air Barriers and accessory material shall have a maximum allowable air leakage rate of 0.004 cfm/sf @ 1.57 psf when tested in accordance with ASTM E 2177.

E. Air barrier shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure.

1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.

B. Shop Drawings: Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1. Include details of interfaces with other materials that form part of air barrier.
2. Include details of mockups.

1.7 INFORMATION SUBMITTALS

A. Qualification Data: For Installer. Provide letter from membrane manufacturer indicating that installer is trained and approved by manufacturer.

B. Product Certificates: For air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with air barrier; signed by product manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers.

D. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Manufacturer: Company with full time technical representatives that can attend preinstallation meetings, field testing, first installation and periodically during installation to ensure that installation is acceptable for manufacturer warranty.

B. Installer Qualifications: A qualified installer who is authorized, approved, or licensed by air barrier membrane manufacturer to install manufacturer's products.

C. Manufacturer Qualifications: A qualified manufacturer who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Design Professional, and whose work has resulted in installations with a record of successful in-service performance for a period of not less than 10 years.

D. Source Limitations: Obtain air barrier materials, transition membranes, primers, adhesives, sealants, and other materials, through one source from a single manufacturer.

E. Mockups: Before beginning installation of air barrier, build mockups of exterior wall assembly, incorporating backup wall construction, external cladding, door frame and sill, insulation, and flashing to demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air barrier membrane.

1. Include junction with roofing membrane, building corner condition, and foundation wall intersection.

F. Preinstallation Conference: Conduct conference at Project site.

1. Include installers of other construction connecting to air barrier, such as roofing, waterproofing, architectural precast concrete, masonry, joint sealants, windows, glazed curtain walls, and door frames.
2. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Store rolls according to manufacturer's written instructions.

D. Protect stored materials from direct sunlight.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace vapor barrier that does not perform according to manufacturer's requirements within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Vapor Barrier Installer's Warranty: Submit installer's warranty signed by Installer, covering Work of this Section for the following warranty period:

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-ADHERING SHEET AIR BARRIER

A. Modified Bituminous Sheet: Impermeable 40-mil- thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC project limits.

B. Manufacturers and Products: Subject to compliance with requirements, provide one of the following or equal:

1. (Basis of Design) GCP Applied Technologies (Grace); Perm-A-Barrier Wall Membrane
2. Henry; Blueskin SA.
3. Tremco, Incorporated; ExoAir 110

C. Physical and Performance Properties:

1. Air permeance in first subparagraph below is based on energy-conservation requirements of the Massachusetts State Building Code, 780 CMR, Chapter 13. Revise to suit Project.
2. Membrane Air Permeance: Not to exceed 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.

3. Tensile Strength: 250 psi minimum; ASTM D 412, Die C, modified.
4. Ultimate Elongation: 200 percent minimum; ASTM D 412, Die C, modified.
5. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
6. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
7. Puncture Resistance: 40 lbf minimum; ASTM E 154.
8. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
9. Vapor Permeance: Greater than 1.0 perms; ASTM E 96, Water Method.

2.2 AUXILIARY MATERIALS

A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of air barrier material.

C. Counterflashing Strip: Modified bituminous 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.

D. Butyl Strip: Vapor-retarding, 30- to 40-mil- thick, self adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive, with release liner backing.

E. Modified Bituminous Strip: Vapor-retarding, 40-mil- thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.

F. Termination Mastic: Cold fluid-applied elastomeric liquid; trowel grade.

G. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

H. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

I. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0250 inch thick, and Series 300 stainless-steel fasteners.

J. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft. density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

K. Modified Bituminous Transition Strip: Vapor-retarding, 40-mil- thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.

L. Elastomeric Flashing Sheet: ASTM D 2000, 2BC415 to 3BC620, minimum 50- to 65-mil- thick, cured sheet neoprene with manufacturer's recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.

M. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

N. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that masonry joints are flush and completely filled with mortar.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.

G. Bridge and cover isolation joints, expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping modified bituminous strips.

H. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

I. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 INSTALLATION

A. Install modified bituminous sheets according to air barrier manufacturer's written instructions and according to recommendations in ASTM D 6135.

1. When ambient and substrate temperatures range between 25 and 40 deg F install self-adhering, modified bituminous air barrier sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F

B. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.

1. Install modified bituminous strips centered over vertical inside corners. Install 3/4-inch fillets of termination mastic on horizontal inside corners.

C. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.

D. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

E. Apply and firmly adhere modified bituminous sheets horizontally over area to receive air barrier sheets. Accurately align sheets and maintain a uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure airtight installation.

1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.

2. Roll sheets firmly to enhance adhesion to substrate.

F. Apply continuous modified bituminous sheets over modified bituminous strips bridging substrate cracks, construction, and contraction joints.

G. Seal top of through-wall flashings to air barrier sheet with an additional 6-inch- wide, modified bituminous strip.

H. Seal exposed edges of sheets at seams, cuts, penetrations, and terminations not concealed by metal counter-flashings or ending in reglets with termination mastic.

I. Install air barrier sheets and auxiliary materials to form a seal with adjacent construction and to maintain a continuous air barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

J. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings using accessory materials according to manufacturer's tested assembly.

K. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition stripso that a minimum of 3 inches of coverage is achieved over both substrates. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.

1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.
2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
3. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and membrane.

L. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air barrier membrane with foam sealant.

M. At end of each working day, seal top edge of membrane to substrate with termination mastic.

N. Apply joint sealants forming part of air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

O. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air barrier sheet extending 6 inches beyond repaired areas in all directions.

P. Do not cover air barrier until it has been tested and inspected by Manufacturer's testing agent and inspectors.

Q. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Design/Builder shall engage the manufacturer to perform tests and inspections and prepare test reports.

B. Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed.
7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
8. Termination mastic has been applied on cut edges.
9. Air barrier has been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

C. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers. Conduct a minimum of two tests in accordance with the specified test method.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E 783.
3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D 4541 for each 600 sq. ft. of installed air barrier or part thereof.

D. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

F. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

B. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed to these conditions for more than 30 days.

C. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by air barrier manufacturer.

D. Clean spills, stains, and soiling from adjacent construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 072713

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Vapor-retarding, fluid-applied air barriers.

B. Related Requirements:

1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
2. Section 072713 "Modified Bituminous Sheet Air Barriers" for modified bituminous sheet air barriers.

C. Contractor Option: Contractor may, at his option, provide fluid-applied membrane air barriers as specified in this Section, or provide modified bituminous sheet air barriers as specified in Section 072713 "Modified Bituminous Sheet Air Barriers" for air barriers.

1.3 DEFINITIONS

A. ABAA: Air Barrier Association of America.

B. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

C. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

D. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.
4. Include 3-dimensionsal axonometric views of inside corners, outside corners, transitions and interfaces with other materials.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Field quality-control reports.

E. Quality Assurance Program Documentation: Provide documentation that Contractor is accredited and that the Installers are certified by the Air Barrier Association of America (ABAA) for the AABA Quality Assurance Program. Submit ABAA accreditation number of the Contractor and the ABAA certification numbers of the Installers.

1. ABAA Audit Reports: Submit a copy of the audit reports no more than 10 working days after the field inspections and tests are performed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
2. Each workman who is installing air barriers shall be recognized as an ABAA Certified Installer by the Air Barrier Association of America (ABAA).
3. ABAA Level 3 Certified Installers shall perform or directly supervise all air barrier work on the Project. Each ABAA Level 3 Certified Installer may supervise a maximum of five ABAA Certified Installers.

4. Installers shall be trained and certified by the Building Performance Quality Institute (BPQI) for the ABAA Quality Assurance Program in accordance with the requirements in the ABAA Quality Assurance Program.

B. Manufacturer Qualifications: A qualified manufacturer who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in installations with a record of successful in-service performance for a period of not less than 10 years.

1. Manufacturer shall be an ABAA Evaluated Manufacturer who has agreed to comply with the ABAA Air Barrier material approval process.

C. Quality Assurance Program: Implement the ABAA Quality Assurance Program requirements used by the Air Barrier Association of America (ABAA).

1. The Contractor, upon award of the Work, shall register the work under this Section with the Air Barrier Association of America (ABAA).

D. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.

1. Build integrated mockups of exterior wall assembly as indicated on Drawings, or if not indicated, at least 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.

   a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
   b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
   c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.

B. Mockup Testing: Air-barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate according to ASTM E783.

3. Adhesion Testing: Mockups will be tested for required air-barrier adhesion to substrate according to ASTM D4541.
4. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

B. VOC Content: 100 g/L or less.

C. Low-Emitting Materials: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E2357.

2.3 HIGH-BUILD AIR BARRIERS, VAPOR RETARDING

A. High-Build, Vapor-Retarding Air Barrier: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 60 mils or thicker over smooth, void-free substrates.

1. Synthetic Polymer Type:

a. Products: Subject to compliance with requirements, provide one of the following:

1) GCP Applied Technologies Inc.; Perm-A-Barrier Liquid.
2) Henry Company; Air-Bloc 32MR.

2. Physical and Performance Properties:

a. Air Permeance: Maximum 0.0002 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.
b. Vapor Permeance: Maximum 0.08 perm; ASTM E96/E96M, Desiccant Method.
c. Ultimate Elongation: Minimum 500 percent; ASTM D412, Die C.
d. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541.
e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
f. UV Resistance: Can be exposed to sunlight for 90 days according to manufacturer's written instructions.

B. Polyethylene-Film-Faced Transition Membrane: 40-mil-thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick, cross-laminated polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC limits.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GCP Applied Technologies Inc.; Perm-A-Barrier Detail Membrane.
b. Henry Company; Blueskin SA.

2. Physical and Performance Properties:

a. Air Permeance: Maximum 0.002 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.
b. Tensile Strength: Minimum 400 psi; ASTM D412, Die C.
c. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.
d. Puncture Resistance: Minimum 40 lbf; ASTM E154/E154M.
e. Water Absorption: Maximum 0.10 percent weight gain after 48-hour immersion at 70 deg F; ASTM D570.
f. Vapor Permeance: Maximum 0.05 perm; ASTM E96/E96M, Desiccant Method.
g. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541 as modified by ABAA.
h. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
i. UV Resistance: Can be exposed to sunlight for 60 days according to manufacturer's written instructions.

C. Polyethylene-Film-Faced Through-Wall Flashing Membrane: 40 mils thick, self-adhering rubberized asphalt or SBS modified bitumen bonded to a high-density polyethylene film.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GCP Applied Technologies Inc.; Perm-A-Barrier Wall Flashing.
b. Henry Company; Blueskin TWF.

2. Physical and Performance Properties:

a. Tensile Strength: Minimum 800 psi; ASTM D412, Die C.
b. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.
c. Puncture Resistance: Minimum 80 lbf; ASTM E154/E154M.
d. Water Absorption: Maximum 0.10 percent weight gain after 48-hour immersion at 70 deg F; ASTM D570.
e. Vapor Permeance: Maximum 0.05 perm; ASTM E96/E96M, Desiccant Method.
f. Lap Adhesion: 60 lbs/ft width, per ASTM D 1876
g. Adhesion to Concrete: 60 lbs/ft width, per ASTM D 903.
h. Tear Resistance, Initiation: Minimum 13 lbs, per ASTM D 1004.
i. Tear Resistance, Propagation: Minimum 9 lbs, per ASTM D 1938.
j. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
k. UV Resistance: Can be exposed to sunlight for 60 days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.

C. Stainless-Steel Sheet: ASTM A240/A240M, Type 304, 0.0250 inch thick, and Series 300 stainless-steel fasteners.

D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; Dow Corning® 123 Silicone Seal.
b. GE Construction Sealants; Momentive Performance Materials Inc.; US11000 UltraSpan.

E. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft. density; flame-spread index of 25 or less according to

ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

F. Counterflashing Strip: Same as Through-Wall Flashing Membrane.

G. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.

H. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

I. Sheet Flashing: Refer to Section 076200 "Sheet Metal Flashing and Trim."

J. Joint Sealants: As recommended by manufacturer for substrate and joint conditions. Refer to Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method according to ASTM D4263.
4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge isolation joints, expansion joints, and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.3 ACCESSORIES INSTALLATION

A. Install accessory materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip or preformed silicone extrusion so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, transition strip.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.4 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.

1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.

B. High-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.

1. Vapor-Retarding, High-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, but not less than 60 mils, applied in one or more equal coats.

C. Do not cover air barrier until it has been tested and inspected by testing agency.

D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Technical Representatives Inspection: The Contractor shall arrange and pay for the air barrier manufacturer's technical representatives to inspect, test, and report all work pertaining thereto. The Contractor shall be responsible for carrying out all recommendations of the manufacturer's technical representatives to ensure a total and complete installation of the air barrier work. The issuance of the manufacturer's technical representative's final inspection reports shall be made prior to the acceptance of the air barrier work by the Owner.

B. ABAA Audits: The Contractor shall arrange and pay for the Air Barrier Association of America (ABAA) audits to inspect, test, and report all work pertaining thereto. The Contractor shall be responsible for carrying out all recommendations of the ABAA audits to verify conformance with the site Quality Assurance Program used by ABAA, the manufacturer's installation instructions, and the requirements of this Section. The issuance of the ABAA audit reports shall be made prior to the acceptance of the air barrier work by the Owner.

1. Number of ABAA Audits: Audit inspection and testing shall be performed at the following rate:

a. Up to 10,000 Sq. Ft. of Air Barrier: One audit.
b. 10,000 to 35,000 Sq. Ft. of Air Barrier: Two audits.
c. 35,000 to 75,000 Sq. Ft. of Air Barrier: Three audits.
d. 75,000 to 125,000 Sq. Ft. of Air Barrier: Four audits.
e. 125,000 to 200,000 Sq. Ft. of Air Barrier: Five audits.
f. 200,000 Sq. Ft. and Over of Air Barrier: Six audits.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness.
3. Continuous structural support of air-barrier system has been provided.
4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
5. Site conditions for application temperature and dryness of substrates have been maintained.
6. Maximum exposure time of materials to UV deterioration has not been exceeded.
7. Surfaces have been primed, if applicable.
8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
9. Termination mastic has been applied on cut edges.
10. Strips and transition strips have been firmly adhered to substrate.
11. Compatible materials have been used.
12. Transitions at changes in direction and structural support at gaps have been provided.
13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
14. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers. Conduct a minimum of two tests in accordance with the specified test method.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783. Conduct a minimum of two tests in accordance with the specified test method.
3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. of installed air barrier or part thereof.

E. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials according to air-barrier manufacturer's written instructions.
2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 074213 - ALUMINUM COMPOSITE PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Metal panel system is designed for rain-screen application using an aluminum extrusion and dry-joint system at vertical applications.
2. Panel mounting system including anchorages, furring, fasteners, gaskets and sealants, related flashing adapters and masking for a complete installation.
3. System has Florida Product Approvals.
4. System shall include shop-installed aluminum stiffeners per manufacturer's recommendations, on all panels of 20 square feet or larger. Minimum stiffener recommendation is one per 20 square feet of panel area.
5. Parapet coping, column covers, soffits, sills, border and filler items may be indicated as integral components of the panels system.
6. All flashing metal required shall be provided by the panel manufacturer.
7. Metal wall panels shall be fire-resistant at panels above 25-feet with R-13 fire-rated core.
8. For insulation for panels below 25-feet, refer to Division 07 “Thermal Insulation” for rigid insulation.

B. Related Section:

1. Division 05 - "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal-faced composite wall panels.
2. Division 06 - “Sheathing.”
3. Division 07 - “Thermal Insulation” for rigid insulation.
4. Division 07 – “Fluid Applied” and “Sheet Applied Air Barriers”.
5. Division 07 "Sheet Metal Flashing and Trim" for field-formed flashings and other sheet metal work not part of metal-faced composite wall panel assemblies.
6. Division 08 "Glazed Aluminum Window and Curtain Walls" for curtain wall system.

1.3 DEFINITION

A. Metal-Faced Composite Wall Panel Assembly: Metal-Faced Composite Wall Panel Assembly: Consisting of a drained and back ventilated rain screen metal-faced composite panel system with extruded panel attachment components, miscellaneous metal framing, perimeter flashings, and accessories necessary for a complete composite wall panel assembly.

1.4 PERFORMANCE REQUIREMENTS

A. Building Code Requirements: Provide composite metal wall panel system that complies with the requirements of the Florida Building Code.

B. Exterior products in this section must have Florida Product Approvals.

C. General Performance: Metal-faced composite wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

D. Engineer metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer licensed to practice in the State of Florida, using performance requirements and design criteria indicated.

E. Water Penetration: Field water testing with ASTM 1105 at a minimum differential pressure of 15 psf

F. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:

1. Wind Loads: The composite wall panel assemblies shall be designed, fabricated, and installed to withstand the maximum inward and outward wind pressures required by the Florida Building Code, and as shown on the Drawings.

2. Deflection Limits:
   a. Normal to plane of wall maximum allowable deflection is limited to L/60.
   b. Maximum allowable deflection of panel stiffeners and metal-faced composite panel material combined is limited to L/60.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

H. Fire Resistance:

1. Surface burning characteristics: Provide metal composite wall system panels with the following characteristics when tested per ASTM E84.
   a. Flame Spread Index: 25 or less
   b. Smoke Developed Index: 450 or less

2. Intermediate Scale Multi-story Fire Test: Mock-up tested in accordance with NFPA 285 utilizing project specific materials.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's product specifications, standard details, certified product test results, and general recommendations, as applicable to materials and finishes for each component and for total panel assemblies.

B. Shop Drawings: Submit shop drawings showing project layout and elevations; fastening and anchoring methods; detail and location of joints, sealant, and gaskets, including joints necessary to accommodate thermal movement; trim; flashing; and accessories.

1. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Submit engineered drawings indicating concealed fasteners. Drawings shall be signed and sealed by a registered engineer licensed in the state of Florida.
3. Shop drawings shall show the preferred joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration, on the inside face of the panel system as determined by ASTM E 331.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal-Faced Composite Wall Panels: Minimum 12 x 12 inches. Include fasteners, closures, and other metal-faced composite wall panel accessories.

   a. Composite Panels: Include four-way joint.
2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: 12-inch- long Samples for each type of accessory.
4. Exposed Gaskets: 12 inches long.
5. Exposed Sealants: For each type and color of joint sealant required. Install joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of metal-faced composite wall panels adjacent to joint sealants.

D. Engineered Submittals: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer who is licensed to practice in the State of Florida and is responsible for their preparation.

E. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Wall panels and attachments.
2. Stud framing.
3. Wall-mounted items including doors, windows, louvers, and lighting fixture.
4. Penetrations of wall by pipes and utilities.

1.6 INFORMATION SUBMITTALS

A. Qualification Data: For professional engineer.

B. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product. Include test reports for code required NFPA 285 fire resistance testing of composite panel assembly to be used on project.

D. Field quality-control reports.

E. Operation and Maintenance Data for maintenance manuals.

F. Warranties: Samples of special warranties.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of metal-faced composite wall panel from single source from single manufacturer.

B. Installer Qualifications: Engage an experienced installer who has completed metal wall panel projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Professional Engineer Qualifications: A professional engineer who registered in the state of Florida and who is experienced in providing engineering services of the kind indicated.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

E. Fire-Resistance Ratings: Where indicated, provide metal-faced composite wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

F. Mockups: Before installing wall panels, construct mockups indicated to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution.

G. Preinstallation Conference: Conduct conference at Project site.

1. Meet with metal-faced composite wall panel Installer, metal-faced composite wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal-faced composite wall panels.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal-faced composite wall panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal-faced composite wall panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal-faced composite wall panel assembly during and after installation.

8. Review wall panel observation and repair procedures after metal-faced composite wall panel installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver panels and other components so they will not be damaged or deformed. Package panels for protection against damage during transportation or handling.

B. Exercise care in unloading, storing, and erecting wall panels to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight and ventilated covering. Store panels to ensure dryness. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal-faced composite wall panels to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify location of structural members and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.10 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive the University of other rights that the University may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Finish Warranty: Submit a written warranty, signed by manufacturer, covering failure of the factory-applied exterior finish on metal wall panels within the specified warranty period and agreeing to repair finish or replace wall panels that show evidence of finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.

C. Finish Warranty Period: 20 years from date of Substantial Completion.

D. Water Tightness Guarantee: Provide a water tightness warrantee covering the complete assembly including, but not limited to, flashings, fasteners, panel clips, gaskets, sealants, and wall panels.

1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPOSITE METAL PANEL SYSTEM

A. System Description: Composite Metal Panel Wall System: Drained and back-ventilated rainscreen design consisting of dry seal joinery designed to minimize water penetration and induce air circulation in the space behind the panels.

1. Panels shall be Fire Resistant (FR) and Aluminum Composite Materials (ACM).

B. Provide one of the following Products and Manufacturers listed below or equal:

1. Alcoa Architectural Products; Reynobond Composite FR Panels
   a. Florida Product Approval: FL11794.1_RO

2. Trespa North America, Ltd; TS 110 Trespa Meteon FR Composite Wall Panels.
   a. Miami Dade NOA No: 13-1211.12

3. West Tampa Glass; WTG 200 System;
   a. Florida Product Approval: FL21387_RO_II

C. Color and finish: to be decided.

2.2 ALUMINUM COMPOSITE PANELS

A. Aluminum faced composite wall panels with mounting system. Panel mounting system including concealed fasteners, shims, furring, gaskets and sealants, related flashing adapters, and masking as required for a complete watertight system.

1. Panel Thickness: 4mm (0.157").

B. Panel Composition: Two sheets of aluminum sandwiching a core of extruded thermoplastic material formed in a continuous process with no glues or adhesives between dissimilar materials. Products laminated sheet by sheet or in a batch process using glues or adhesives between materials are not acceptable.

1. Aluminum Face Sheet Thickness: 0.50mm (0.0197")
   a. Alloy: AA3003 Painted material.
2. Panel Weight: 4mm (0.157"): 1.12 lbs./ft^2

C. Tolerances:

1. Panel Bow: Maximum 0.8% of panel dimension in width and length.
2. Panel Dimensions: Field fabrication shall be allowed where necessary, but shall be kept to an absolute minimum. All fabrication shall be done under controlled shop conditions when possible.
3. Panel lines, breaks, and angles shall be sharp, true, and surfaces free from warp and buckle.
4. Maximum deviation from panel flatness shall be 1/8" in 5'0" on panel in any direction for assembled units. (Non-accumulative)

2.3 FIRE RESISTANT ALUMINUM COMPOSITE PANELS

A. Product Characteristics: Composite Metal Panels: Factory-formed, aluminum-faced composite panels fabricated from two sheets of 0.020 inch thick aluminum facing sheets with metal facings bonded to thermoplastic core, and rout and return joinery.

B. Fire Resistant Core (FR):

1. Thickness: 4 mm nominal.
2. Panel Flatness: Maximum allowable distortion: 1/32 inch in 24 inches in any direction.
3. Panel Core: Thermo-set polymeric, fire-retardant.

   a. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL:
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 450 or less.
4. Stiffeners: Manufacturer's standard stiffener as required to meet performance requirements.
5. Face Sheet Surface: Smooth.
6. Finish: as selected by Design Professional.

C. Attachment System Components: Formed from extruded aluminum.

D. Include custom perimeter flashings to accommodate project specific cavity depth. All perimeter flashings must be fully integrated with water-resistive air barrier. Dry System (DS):

1. Nominal 2 1/2-inch depth with shop applied, concealed continuous perimeter extrusions without intermittent extrusions or clips at panel perimeter. Nominal 1/2” vertical and horizontal joinery. Panel system shall employ shop attached clips to the continuous perimeter extrusions with sliding capability for exact location over supports, while allowing for thermal movement in all four directions, minimizing stress on panels.

   a. All rivets and fasteners that are used to attach the composite metal sheet to the perimeter extrusions shall be counter sunk, painted the same color as the panel and aligned both vertically and horizontally.

2. Rainscreen type with no exposed sealants in the panel to panel joinery.

   a. Panel joints to utilize Metal Composite Material spline with same composition as the panels without bonding of metal material within the joinery in order to simulate an encapsulated spline.

3. Horizontal soffit panels to have baffled weep holes in every panel. Splines to be held in place by slots in the perimeter panel extrusions.
4. Shop Fabricated: panel system shall be shop fabricated and not fabricated in the field.
5. Panel system shall be provided in panel modules and lengths as indicated on the Contract drawings.
6. Panel system to be applied over properly installed air barrier, see Division 07 Section "Air Barriers."

2.4 SYSTEM CHARACTERISTICS

A. System Characteristics. Plans, elevations, details, characteristics, and other requirements indicated are based upon standards by one manufacturer. It is intended that other manufacturers may be acceptable provided their details and characteristics comply with size and profile requirements, and material/performance standards as follows:

1. System shall provide a wet seal reveal joint or an aluminum extrusion as detailed on drawings. Sealant type shall be as specified in Division 11 “Joint Sealants” with foamed type backer rod.
2. System shall not have any visible fasteners, telegraphing or fastening on the panel faces or any other compromise of a neat and flat appearance.
3. System shall comply with the applicable provisions of the "Metal Curtain Wall, Window, Storefront, and Entrance Guide Specifications Manual" by AAMA and ANSI/AAMA 302.9 requirements for aluminum windows.
4. Fabricate panel system to dimension, size, and profile indicated on the drawings based on a design temperature in accordance with local design ambient conditions.
5. Fabricate panel system so that no restraints can be placed on the panel which might result in compressive skin stresses. The installation detailing shall be such that the panels remain flat regardless of temperature changes and at all times remain air and water tight.
6. The finish side of the panel shall have a removable plastic film applied prior to fabrication that shall remain on the panel during fabrication, shipping, and erection to protect the surface from damage.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.

1. Use aluminum or stainless-steel fasteners for exterior applications and aluminum fasteners for interior applications.
2. Provide washers and weather seals as necessary at exterior penetrations.

B. Accessories: Provide the following.

1. Extrusions, formed members, sheet, and plate shall conform with ASTM B209 and the recommendations of the manufacturer.
2. Panel stiffeners, if required, shall be structurally fastened or restrained at the ends and shall be secured to the rear face of the composite panel with silicone of sufficient size and strength to maintain panel flatness. Stiffener material and/or finish shall be compatible with the silicone.
3. Sealants and gaskets within the panel system shall be as per manufacturer's standards to meet performance requirements.
4. Fabricate flashing materials from 0.030" minimum thickness aluminum sheet painted to match the adjacent curtain wall / panel system where exposed. Provide a lap strap under the flashing at abutted conditions and seal lapped surfaces with a full bed of non-hardening sealant.
5. Fasteners (concealed/exposed, non-corrosive/concealed and exposed, non-corrosive): Fasteners as recommended by panel manufacturer. Do not expose fasteners except where unavoidable and then match finish of adjoining metal.

2.6 SECONDARY FRAMING

A. Panel Supports and Anchorage: Provide girts, furring channels, angles, plates, bracing, and other secondary framing members.

1. Girts: C- or Z-shaped sections fabricated from 0.0598-inch-thick, shop-painted, roll-formed steel.
2. Flange and Sag Bracing: 1-5/8-by-1-5/8-inch angles, fabricated from 0.0598-inch-thick, shop-painted, roll-formed steel.
3. Base or Sill Angles: Fabricate from 0.079-inch-thick, cold-formed, galvanized steel sections.
4. Secondary structural members, except columns and beams, shall be manufacturer's standard sections fabricated from 0.079-inch-thick, cold-formed galvanized steel.

2.7 FABRICATION

A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Metal-Faced Composite Wall Panels: Factory form panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant.
3. Dimensional Tolerances:

   a. Panel Bow: 0.8 percent maximum of panel length or width.
   b. Squareness: 0.25 inch maximum.

C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.

   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.
4. Perimeter flashing splices: It is critical that all perimeter flashing splices adjacent to weather seals be designed to be air and water tight. Splice must be designed to accommodate all anticipated thermal movement of metal without failure of sealant, incorporate a sealed metal splice sleeve on wet cavity side of construction and be sealed

with the same sealant as specified in Section 07 92 00 to be used for exterior weather seal. Standard lapped and bed sealed sheet metal splices will not be accepted.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 METALS AND FINISHES

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Surface: Smooth, flat finish.

2. Exposed Coil-Coated Finishes:

a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Metal Panel finish colors (in order of preference):

1. Reynobond - Natural Metals Brushed Aluminum (RB4NBA)
2. Alucobond Natural Brushed 50
3. Reynobond – Natural Metals Long Brushed Aluminum (RB4LBA)
4. Alpolic AM HLZ Aluminum (#4mm4HLZ3.5)

C. Panel Sealants:

1. Joint Sealant: Refer to Division 07 Section “Joint Sealants”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.

2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.

3. Verify that fluid-applied membrane air barrier and integral perimeter flashing has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

3.3 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install metal-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Commence metal-faced composite wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
2. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
3. Flash and seal metal-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
4. Install flashing and trim as metal-faced composite wall panel work proceeds.
5. Provide a joint for installation of sealant and backer rod between sill angle and adjacent substrate.

6. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
7. All penetrations must be sealed air and water tight at face of water-resistive air barrier.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

C. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

D. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations, spacings, with specified fasteners. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners. Panel clips to be attached to panels at the factory in lieu of field applied.

E. Install wall panels to allow individual panels to “free float” and be installed and removed without disturbing adjacent panels. No joint sealants shall be utilized at typical vertical or horizontal joints. Panel joints shall include a spline fabricated from same MCM system as panels.

F. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, with specified fasteners. Attach wall panels by interlocking perimeter extrusions attached to routed-and-returned flanges of wall panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal.

1. Do not apply sealants to joints unless otherwise indicated on Drawings.

3.4 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at 12 lbf/sq.ft pressure differential.

1. Test must be conducted prior to interior insulation and interior gypsum finishes are installed so interior side of exterior sheathing is fully exposed to view.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, and adjust completed metal-faced composite wall panel installation, including accessories.

D. Metal-faced composite wall panels will be considered defective if they do not pass tests and inspections.

E. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.7 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074243

SECTION 074247 -- ULTRA HIGH PERFORMANCE CONCRETE PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following:

1. Furnishing and installation of factory-molded, ultra-high performance concrete (UHPC) solid exterior wall panels and pre-engineered support structure (system).
2. Panels shall be for exterior applications.
3. Panels shall be provided with all pre-drilled fastening holes.
4. Exterior applications shall include pre-drilling of holes for exposed and concealed fastening anchors.

B. System Description: Complete system shall include the design and installation of the solid exterior wall panels and support structure system to provide, in conjunction with wall substrate and air barrier, a weather-tight wall assembly utilizing rain screen principle.

C. Related Requirements:

1. Division 05 Section "Cold-Formed Metal Framing" for sub-framing to cladding panels.
2. Division 06 Section “Sheathing."
3. Division 07 Section "Thermal Insulation".
4. Division 07 Section "Fluid-Applied Membrane Air Barrier" for air barriers.
5. Division 07 Section "Flashing and Sheet Metal" for field - formed flashings and other sheet metal work not part of cementitious composite wall panel assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. Provide wall cladding comprising panels, system components, accessories and supports such that the cladding complies with performance requirements indicated below and is capable of withstanding structural movement, thermally induced movement and exposure to weather without failure.

B. Failure also includes the following:

1. Thermal stresses transferring to building structure.
2. Solid exterior wall panels and support structure cracking or breakage.
3. Noise or vibration created by wind and thermal and structural movements.
4. Loosening or weakening of fasteners, attachments, and other components.

C. Structural Loads: Provide cladding panels and sub-framing capable of withstanding design wind, structural, and pressure loads as indicated on structural drawings and according to the 2017 Florida Building Code.

D. Structural Performance: provide solid exterior wall panel and support system as follows:

1. Will not evidence deflection exceeding specified limits.
2. At 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, will not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Durations: As required by design wind velocity, but not less than 10 seconds.
4. Deflection of Framing Members: At design wind pressure, as follows:

   a. Deflection Normal to Wall Plane: Limited to edge of panel in a direction perpendicular to panel plane not exceeding L/240 of the panel edge length for each panel or an amount that restricts edge deflection of individual panels to manufacturer's product limitations, whichever is less.
   b. Deflection Parallel to Panel Plane: Limited to L/360 of clear span or 1/8 inch, manufacturer's product limitations, whichever is smaller.
   c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to 2 times the length of cantilevered member divided by 175, or manufacturer's product limitations, whichever is smaller.

E. Story Drift: Accommodate design displacement of adjacent stories.

F. Design Displacement: As indicated on Structural Drawings.

G. Maximum Solid Exterior Wall Panels Deflection: 1/360 of span or less when tested in accordance with positive and negative pressures.

H. Anchorage system: Wall anchorages for exterior systems shall be designed to pre- vent thermal transfer through fasteners to interior side of cold-formed metal framing which could result in condensation inside the stud cavity.

I. Thermal Movements

1. Allow for thermal movements from ambient and surface temperature changes by preventing buckling, overstressing components, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   Temperature Change (Range): 120 deg F, ambient; 180 deg P, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Engineered Shop Drawings: Shop drawings shall be prepared by an Engineer licensed in the State of Florida and include:

1. All Panel Supports and Sub-framing;
2. Fasteners and fastening schedules;

3. Layout, profiles and product components, including edge conditions, panel joints, fixture location, anchorage, accessories, finish colors, patterns and textures. Show all panels, joints, adjacent materials, openings, returns, attachments, substrate attachments and other features showing a complete system.

C. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Wall panels and attachments.
2. Stud framing.
3. Wall-mounted items including doors. windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

D. Samples for initial selection: panels with manufacturer's surface sheen, texture and colors.

E. Samples for Verification: For each type, color, texture, and sheen required. Representative of finished exposed face of solid exterior UHPC panel. For each color and pattern specified, submit a minimum of two samples, each not less than 6 by 6 inches, and of actual thickness.

1. Each sample to be labeled and dated. Approved sample to be stamped approved and returned to manufacturer for reference.
2. Sub-framing system: 12-inches long.

F. Product certificates signed by manufacturers certifying materials comply with specified performance characteristics and criteria and physical requirements.

G. Test Reports: Submit certified test reports showing compliance with specified performance characteristics and physical properties.

H. Research/Evaluation Reports: For ultra-high performance concrete panels, from ICC-ES.

I. Installer Qualifications: Submit written documentation from panel manufacturer or manufacturer's authorized distributor that the installer has been trained in the proper handling and installation of the specified wall panels.

J. Submit documentation that installer has completed at least three cladding installations in the past five years similar in material, design, and scope.

K. Sample Warranty: For special warranty.

L. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer's Qualifications: A qualified installer who is authorized, approved, or licensed by manufacturer to install manufacturer's products, at least five years' experience in installing materials of types specified and having successfully completed at least five projects of similar scope and complexity.

1. Installer shall designate a single individual as project foreman who shall be on site at all times during installation.

B. Professional engineer qualification: A professional engineer who is legally qualified to practice in the State of Florida and experienced in providing engineering services.

C. Mockup: Build exterior, free-standing mockup of typical UHPC wall, in location as directed by Design Professional.

1. Mockup for UHPC wall panels shall be full-size, physical assemblies, constructed on-site to illustrate finish and materials.
2. Mockup shall be used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.
3. Mockups shall be scheduled well in advance of actual construction of the specified area to allow adjustments in material use, material selections and construction techniques.
4. Approved mock-ups shall establish the standard by which the Work will be judged.
5. Dimensions of mockup shall be indicated on drawings.

D. Preinstallation Conference: Conduct pre installation meeting on site in the presence of Contractor, Owner's representative, Design Professional and panel manufacturer's representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior solid UHPC wall panels and support system components packaged to comply with manufacturers' requirements and adequately protected from damage during shipment.

B. Protect components from adverse job conditions prior to installation.

C. Protect components from other trades after installation.

D. Panels are to be stored and handled vertically until installed.

E. Store exterior solid UHPC wall panels and support system components on platforms or pallets, covered with tarpaulins or other suitable weather-tight ventilated covering. Store components so that water accumulations will drain freely.

F. Do not store exterior solid UHPC wall panels and support system components in contact with other materials that might cause staining, denting, surface damage or other deleterious effects.

1.7 PROJECT CONDITIONS

A. Field Measurements:

1. Verify actual measurements/openings by field measurements before material fabrication, and show recorded measurements on shop drawings.
2. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.8 COORDINATION

A. Coordinate UHPC Panels with installation of flashings and other adjoining construction to ensure proper sequencing.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including cracking and deforming.
   b. Deterioration of materials beyond normal weathering.
   c. Failure of components of panel assembly supplied by the manufacturer.
   d. Color fading more than 5 Hunter units when treated according to ASTM D 2244.
2. NOTE: Basis of Design manufacturer does not include “efflorescence” as a product failure in their limited warranty due to factors outside their direct.

B. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers in compliance include:

1. (Basis of Design) TAKTL; TAKTL; Patterned Wall and Façade Panels, factory-formulated with TAKTL® ultra high performance concrete and reinforced with alkali-resistant (AR) glass mesh.
2. SHApe Architectural; Envel, Ultra High Performance Concrete cladding.
3. Other manufacturer: to be determined.

B. Florida Product Approvals: In process.

2.2 ULTRA HIGH PERFORMANCE CONCRETE (UHPC) PANELS

A. Panel Performance Characteristics:

1. Thermal Expansion (ASTM C531-00): 6.41E-06 in/in/degree F
2. Material Behavior in Vertical Tube Furnace @ 750 degrees C (ASTM E136-09): Pass
3. Density – Thin Panel (ASTM C1185-08): 137 lbs./ft³ .
4. Flexural Strength (Thin Panel) – Dry (ASTM C1185-08): Pass, Mean length direction not less than 3,800 lbs./in² and width direction 3,600 lbs./in².
5. Flexural Strength (Thin Panel) – Wet (ASTM C1185-08): Pass, Mean length direction not less than 3,800 lbs./in² and width direction 3,400 lbs./in².
6. Freeze/Thaw (Cladding) (ASTM C1185-08): Pass. No visible cracks and not less than 90% post-exposure strength retention.
7. Moisture Content – Thin Panel (ASTM C1185-08): less than 1.0%
8. Moisture Movement – Thin Panel (ASTM C1185-08): 0.00%
9. Warm Water (ASTM C1185-08): Pass. No visible cracks or structural alteration.
10. Not less than 90.0% ratio of retained post-exposure strength.
11. Water Absorption - Thin Panel (ASTM C1185-08): less than 4.0%
12. Water Tightness (ASTM C1185-08): Pass. No water droplet formation.
13. Anchor Pullout Strength (ASTM E488-96): 8.5 mm embed in 13mm thick panel
    a. Tension (Min. Mean) Peak Load – 386 lbf or greater
    b. Shear (Min. Mean) Peak Load – 650 lbf or greater

14. Surface Burning Characteristics (ASTM E84-09):
    a. Flame Spread – Pass
    b. Smoke Developed – Pass
    c. Class A.

15. Colorfastness & Weathering (500 hours) (ASTM G155-05a & D2244-09a):
    a. 2.07 delta E. without coating (standard, varies with pigment type, texture and coating)
16. Compressive Strength (ASTM C873): ≥ 18,332 lbs./in² (126 MPa).
17. Tensile (splitting matrix prism) Strength (ASTM C496): 1,319 lbs./in² (9 MPa).

B. Finish exposed, front-facing surface of UHPC as follows, to match approved design reference sample. Panel faces shall be free of joint marks, grain, or other obvious defects.

1. Panel Finishes:
    a. Color: White 87.
    b. Texture: Rough 1.

C. Panel Sizes: Vary and as indicated on approved panel/part layout shop drawings submittals..

D. Panel Dimensional Tolerances
1. Panel Thickness: 1/2-inch nominally, thickness variation +/- 1/16
2. Panel Edges: Mitered and fully adhered at all outside panel corners, mitered (open joint) at all inside corners. Cast corners as indicated on shop drawings
3. Panel Weight: 5.7 lbs/ ft² , at 1/2-inch thickness

2.3 SUPPORT STRUCTURE (PROVIDED BY INSTALLING CONTRACTOR)

A. Aluminum Support Structure:

1. Complete sub-frame assembly to support and anchor solid exterior solid UHPC wall panels.
2. Aluminum support structure to be anchored to building structure.

B. Components:

1. Horizontally-oriented concealed fastener attachment system support bracket/angle bracket anchored directly to building structure.
2. Vertical girt profile, shelf shimming extrusions or cold formed channels that fasten into support brackets and supports.
3. Horizontal support rails: Extruded Aluminum ‘C’ shaped rails with ‘mated’ ‘C’ clips attached to girt profile which provides means to suspend UHPC wall panels.
4. Fasteners: Corrosion-resistant stainless steel fasteners and anchors of type, size and spacing required for type of substrate and project conditions.

2.4 AUXILIARY MATERIALS

A. Auxiliary materials: to be supplied by installing contractor.

B. For Exposed Attachment Face fasteners flush to face of UHPC panel fastened into horizontal or vertical hat channel support member. Panel fastener holes to be factory-drilled by UHPC manufacturer.

1. Basis-of-Design Product/Manufacturer (Exposed): TAKTL color-matched powder coated stainless steel face fasteners for façade panels; provided by panel manufacturer

C. Panel Anchors: Concealed, undercut type, for attaching UHPC panels to panel-mounted extruded aluminum ‘C’ clips and substructure support system.

1. Panel anchor holes to be factory pre-drilled by UHPC panel manufacturer.
2. Manufacturer’s preferred anchoring system:
   a. (Basis of Design) KEIL Concealed Anchoring System for Facade Panels, Naples FL.

D. Adhesives: As recommended in UHPC panel manufacturer's written instructions.

E. Stainless Steel Drill Screws: Of sufficient lengths and sizes to securely fasten support structure to building wall framing members, and as follows:

1. Screws complying with ASTM C 1002 for fastening to steel members less than 0.033 inches thick.
2. Screws complying with ASTM C 954 for fastening to steel members from 0.033 to 0.112 inches thick.

2.5 PANEL FABRICATION

A. General: Fabricate wall panels at the factory to greatest extent possible.

B. Field-cut panels and drill face-fastening anchor holes in accordance with the UHPC panel manufacturer’s written directions.

C. Fabricate all panels to profiles, colors and textures per samples and approval selected by the Architect.

D. Fabricate panels in accordance with manufacturers' Quality Management System Tolerances and Acceptance Criteria.

2.6 FABRICATION TOLERANCES

A. Manufacturing Tolerances: Manufacture UHPC panels so each finished unit complies with the following dimensional tolerances.

1. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: plus or minus 1/16 inch.
2. Weight of finished panels not to exceed 7.4 pcf.
3. Edge Return Thickness: Plus 5/8 inch, minus zero inch.
4. Texture and Reveal Depth: Maximum 1/8 inch.
5. Thickness: Plus 1/4 inch, minus zero inch.
6. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/16 inch per 72 inches or plus or minus 1/8 inch total, whichever is greater.
7. Local Smoothness: 1/8 inch per 10 feet.
8. Bowing: Not to exceed L/240 unless unit complies with erection tolerances using connection adjustments.
9. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch.

10. Location of Window Opening within Panel: Plus or minus 1/4 inch.
11. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches of distance from nearest adjacent corner.

B. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.

1. Panel Alignment: Plus or minus 1/8 inch.
2. Special Handling Devices: Plus or minus 3 inches.(where applicable)
3. Location of Bearing Devices: Plus or minus 1/16 inch.
4. Cutouts: Plus or minus 3/8 inch. Refer to manufacturer's guide to cutouts and notching of panels in the field cutting instructions.

C. Color Variation and Aggregate Distribution Variation Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.

D. Blemishes and Chips Acceptance Criteria: Per Manufacturer's Tolerances and Acceptance Criteria.

E. Acceptance of installed panels shall be assessed when viewed from a distance of 20 ft., under even light, and from a position 90 degrees to the building elevation.

PART 3 - EXECUTION

3.1 MANUFACTURERS INSTRUCTIONS

A. Compliance: Comply with manufacturers' product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.2 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of Fiber Cement Rainscreen Panels and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.4 ERECTION AND INSTALLATION

A. Install wall reinforcements, channel cleats, clips, hangers, and other accessories, for connecting UHPC wall panels to supporting members and backup materials according to approved engineered shop drawing submittals.

B. Provide miscellaneous reinforcement of adhered panel parts, and unitized panel parts, according to manufacturer and installation contractor's engineered shop drawings.

C. Lift UHPC wall panels and install without damage.

D. Install UHPC panels level, plumb, square, and in alignment.

E. Provide temporary supports and bracing, according to approved engineered shop drawings, to maintain position, stability, and alignment of panels until permanent connections are completed.

1. Maintain horizontal and vertical joint alignment and uniform joint w

F. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Do not install damaged components.
2. Install fasteners according to manufacturer's Design Installation Manual.

3.5 EXTERIOR CLADDING FOR RAINSCREEN APPLICATIONS

A. Rain Screen Installation: Comply with manufacturer's installation requirements.

B. Detailing Requirements:

1. Air space at top and bottom of building or wall termination shall be 1/ 2 inch to 3/4 inch to facilitate airflow from behind the panels. Do not block vertical airflow at windows, doors, eaves, or at the base of the building. Airflow shall be continuous from bottom to top so there is air movement behind each panel. For walls over 60 feet high (18 m), the ventilated cavity between rear of panels and exterior wall shall be increased to 1-1/4 inches (30 mm). Air flow behind the cement fiber panels is critical to the performance of the rain screen constructions.
2. Fasteners in profile shall accommodate thermal expansion/contraction of metal and not interfere with panel application.
3. Pattern and Panel Size: As indicated on drawings.

C. Sub framing installation tolerances: Shim and align sub framing to the following installed tolerances:

1. Within 1/4 inch in 20 feet on level, plumb and panel joint lines
2. Joint widths shall be within 1/16 of specified widths
3. Sub frame profile face alignment maximum 1/300 between panel support profiles.

3.6 QUALITY CONTROL

A. Installing contractor shall perform daily inspections of panel installation to maintain and confirm that tolerances are being met and in compliance with panel manufacturer’s Design Installation Manual.

B. University may engage a third party inspection agency to verify that installed panels meet performance requirements and tolerances.

3.7 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074647

SECTION 075416 - ETHYLENE INTERPOLYMER (KEE) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Adhered KEE membrane roofing system on concrete roof deck.
2. Roof insulation.
3. Walkway pads.
4. Roof expansion joint covers constructed of roof membrane system and components.
5. Pre-formed flashing sleeves

B. Related Sections:

1. Division 01 “Sustainable Design” for additional LEED requirements.
2. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter-flashings.
4. Division 07 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Division 22 Section "Plumbing Piping Specialties" for roof drains.

C. Single Source Responsibility: KEE membrane roofing, insulation, adhesives, expansion joints and sheet metal flashing and trim, shall be furnished and installed by a single entity solely responsible for the roofing systems.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.4 CODE COMPLIANCE

A. Roofing membrane system shall meet the Florida Building Code wind load requirements.

1. Provide product evaluations and installation requirements indicating compliance with wind criteria indicated.

B. Roof systems and components shall have current Florida Product Approval indicating that the system has been satisfactorily tested to resist wind uplift design pressures determined by the project structural engineer.

1.5 REFERENCES

A. National Roofing Contractors Association publication, National Roofing Contractors Association Roofing and Waterproofing Manuals

B. Sheet Metal and Air Conditioning Contractors' National Association publication, Architectural Sheet Metal Manual for the design of metal flashing, trim, and roofing

C. Underwriters Laboratories Inc. publications, Roofing Systems and Materials Directory and Building Materials Directory.

1.6 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7 for the project location and wind loads indicated on the structural drawings.

D. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.

E. Roofing system shall comply with the following:

1. Fire/Windstorm Classification: FM Class 1A-90.
2. FM 1-49 Loss Prevention Data Sheet for Perimeter Flashing.
3. FM 1-28 Loss Prevention Data Sheet for Wind Loads to Roof Systems and Roof Deck Securement.
4. FM 1-29 Loss Prevention Data Sheet Above Deck Roof Components.
5. NRCA Manual for Low-Slope Roofing Construction Details (Last Edition).
6. SMACNA Manual (Last Edition). 07502.2.7 ASCE 7, Chapter 6.

F. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 82 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Action Submittal:

1. Product Test Reports for Heat Island Roof: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.

C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

D. Samples for Verification: For the following products:

1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
2. Roof insulation.

1.8 INFORMATION SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer.

B. Informational LEED Submittals: Comply with Division One Section "Sustainable Design Requirements" for the following Building Product Disclosure and Optimizations:

1. Environmental Product Declarations.
2. Sourcing of Raw Materials.
3. Material Ingredient Optimization.
4. Product Manufacturer Supply Chain Optimization.

C. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

E. Research/Evaluation Reports: For components of membrane roofing system.

F. Field quality-control reports.

G. Maintenance Data: For roofing system to include in maintenance manuals.

H. Warranties: Sample of special warranties.

I. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed and FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1. Experience: Minimum 5-years installing the specified roofing system and certified by the manufacturer under the same firm name.

C. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing.

D. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

F. Observation off Installation by University Personnel: The University shall be given two (2) weeks advance notice of intent to start installation of roofing materials. Designated University personnel must be permitted to perform a pre-installation inspection of roofing materials and equipment, to be present throughout roofing installation to observe installation techniques for compliance with specifications and to participate in final inspection.

G. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with University, Architect, University's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.11 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, substrate board, roofing accessories, roof pavers, and other components of membrane roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:

1. Warranty Period: Five years from date of Substantial Completion.

C. Roofing and Flashing Guarantee: The General Contractor, Roofing Subcontractor and the manufacturer(s) of materials used shall jointly furnish a written 20¬year guarantee on the complete roof installation. Submit the guarantee in triplicate. The guarantee shall begin when the project is completed and accepted by the University.

D. The guarantee shall cover, at no cost to the University, all labor and materials required to repair or replace roofing, flashings, sheet metal and copings as necessary to fully correct leaks, faulty workmanship or defective materials.

PART 2 - PRODUCTS

2.1 KEE MEMBRANE ROOFING

A. KEE Sheet: ASTM D 6754-15, fabric reinforced.

B. Manufacturers and products: provide one of the following or equal:

1. (Basis of Design) Seaman; Fibertite XT
   a. Single Ply Roof System over Steel Decks
   b. NOA No: 16-0518.08 Expiration: 01/05/21

2. Acceptable manufacturers and products include:

   a. Carlisle; Sure-Flex KEE/PVC; FL 16438-R4
   b. Duro-Last EV 60-MIL; 16039.1.
   c. Mule-Hide PVC/KEE Single Ply Roofing; FL19969

C. Product Characteristics:

1. Thickness: 50 mils, nominal.
2. Exposed Face Color: White.
3. Energy attributes:

   a. Initial Solar Reflectance ASTM C1549: 0.87
   b. Solar Reflectance (3 yr aged) ASTM C1549: 0.71.
   c. Initial Thermal Emittance ASTM C137: 0.85
   d. Thermal Emittance (3 yr aged) ASTM C1371: 0.84.
   e. Solar Reflective Index (SRI) ASTM E1980: 110.
   f. Solar Reflective Index (SRI) (3 yr aged) ASTM E1980: 86.
   g. Energy Star: YES
   h. LEED v4 - Heat Island Reduction SS Credit: 1 Credit.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.

1. Adhesives and sealants that are on the interior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Single-Ply Roof Membrane Adhesives: 250 g/L.
   f. Other Adhesives: 250 g/L.
   g. PVC Welding Compounds: 510 g/L.
   h. Adhesive Primer for Plastic: 650 g/L
   i. Single-Ply Roof Membrane Sealants: 450 g/L.
   j. Nonmembrane Roof Sealants: 300 g/L.

k. Sealant Primers for Nonporous Substrates: 250 g/L.
l. Sealant Primers for Porous Substrates: 775 g/L.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as KEE sheet membrane.

C. Full Spread Bonding Adhesive: Manufacturer's standard.

D. Slip Sheet: Manufacturer's standard, of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.3 SUBSTRATE AND COVER BOARDS

A. Manufacturers and products: provide one of the following or equal:

1. (Basis of Design) Georgia Pacific; DensDeck Prime Roof Board.
2. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
3. USG Corporation; Securock Glass Mat Roof Board.

A. Adhesive: Two-component low-rise adhesive designed for anchoring acceptable roof insulation to acceptable substrates and to adhere multiple layers of insulation and coverboard.

2.4 BASE-PLY SHEET INSTALLATION

A. Install base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water. Extend glass-fiber base-ply sheets over and terminate beyond cants.

1. Embed each glass-fiber base-ply sheet in a continuous mopping of hot roofing asphalt, to form a uniform membrane without glass-fiber base-ply sheets touching.

2.5 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

B. General: Preformed roof insulation boards manufactured or approved by KEE membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

C. Manufacturers and products include the following or equal:

1. Atlas Roofing Corporation; Atlas Roof Insulations
2. GAF “GAF EnergyGuard:
3. RMax; Multi-Max
4. Seaman "Roof Insulation"
5. SIKA; Sarnatherm

D. Non-tapered insulation shall be a minimum of 4" thickness.

E. Roof insulation shall have an average thermal performance of R-25.

F. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

G. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

D. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

E. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.7 ROOF WALKWAY PADS

A. Walkway Pads: Membrane with slip-resisting surface texture, manufactured specifically for adhering to Ethylene Interpolymer (Kee) roofing as a protection course for foot traffic.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Provided by roof membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Install substrate board on metal deck beneath rigid insulation.
2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.4 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Adhered Insulation on Concrete Deck: Install each layer of insulation and adhere to substrate as follows:

1. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

H. Mechanically Fastened Insulation on Metal Deck: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

I. Install slip sheet over insulation or cover board and immediately beneath membrane roofing.

3.5 ROOFING INSTALLATION, GENERAL

A. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

D. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

E. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

3.6 ADHERED MEMBRANE ROOFING INSTALLATION ON CONCRETE DECKS

A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.

B. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

C. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.

3.7 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 WALKWAY PADS:

A. Provide walkway pads from roof access ladder to each major equipment item using units of size indicated or, if not indicated, of manufacturer's standard size.

1. Adhere walkway pads as required by membrane manufacturer.

3.9 PREFORMED FLASHING-SLEEVE INSTALLATION

A. Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to observe leak detection tests and to determine and report leaks.

B. In-Progress Roof Inspections: Arrange for roofing system manufacturer's technical personnel to inspect roofing system installation periodically during installation. Arrange for a minimum of four (4) inspections on each major roof area, including one during insulation installation, one toward beginning of membrane installation, one at 50% completion, and one at 75% completion. There

are approximately six (6) major roof areas which shall receive the four (4) in-progress roof inspections. Additional inspections shall be provided as warranted by application and as required by manufacturer for issuance of warranty.

C. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reapply roofing, and repair flashing.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

E. Submit written reports of field quality control inspections.

F. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

G. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and University.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

D. Clean Up: debris must not be allowed to accumulate on roof during construction. All debris to be totally removed at completion of project.

3.12 POST CONSTRUCTION FIELD INSPECTIONS

A. The manufacturer’s representative shall conduct two post construction field inspections, as follows:

1. No earlier than eleven months and no later than twelve months after date of substantial completion.
2. No earlier than twenty-three months and no later than twenty-four months after date of substantial completion.
3. Submit a written report within seven days of these visits to the University’s Maintenance Department listing observations and recommended repairs or remedial action.

END OF SECTION 075416

SECTION 075600 – (ALTERNATE) FLUID-APPLIED ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide a cold-fluid-applied polyurethane roofing/waterproofing system on cover board over board insulation.

1. Work includes substrate preparation.
2. Work includes bridging and sealing air leakage and water intrusion pathways and gaps including connections of the walls to the roof air barrier, and penetrations of the building envelope including piping, conduit, ducts and similar items.

B. Related Sections:

1. Division 01 "Alternates" for alternates for Fluid Applied Roofing.

C. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Division 03 Section – Cast-In-Place Concrete.
2. Division 06 Section – Sheathing.
3. Division 07 Section – Flashing and Sheet Metal.
4. Division 07 Section – Joint Sealants
5. Division 21 – Roof Drains.

1.3 PERFORMANCE REQUIREMENTS

A. Cold fluid applied polyurethane roofing/waterproofing system is intended to perform as a continuous barrier against liquid water and to flash or discharge to the exterior incidental water. Membrane system is expected to remain exposed and shall accommodate movements of building materials as required with accessory sealant materials at such locations such as, changes in substrate, perimeter conditions and penetrations.

B. Installed roofing/waterproofing membrane system shall not permit the passage of water, and will withstand the design pressures calculated in accordance with the most current revision of ASCE/SEI 7.

C. Manufacturer shall provide all primary roofing/waterproofing materials that are physically and chemically compatible when installed in accordance with manufacturers current application requirements.

D. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

E. Roofing System Design: Tested by a qualified testing agency to resist uplift pressures as indicated on structural contract documents.

F. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-120.
2. Hail Resistance Rating: MH.

G. Energy Star Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

H. Energy Performance: Roofing system shall have an initial solar reflectance not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

I. Florida Product Approvals Listing: Manufacture and install roofing membranes that are listed as Florida Product Approvals.

J. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

K. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

1.4 SUBMITTALS

A. Product Data: Provide current standard printed product literature indicating characteristics of membrane materials, flashing materials, components, and accessories product specification and installation; submit copies of current Material Safety Data Sheets (MSDS) for components of the work:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Cleaning methods.

B. Shop Drawings: Submit shop drawings of cold fluid-applied reinforced polyurethane showing a project plan, size, flashing details, and attachment for review and approval by the Owners Representative, Design Professional and Membrane Manufacturer.

C. Warranty Documentation: Submit 2 executed copies of both the manufacturer and applicator warranties for the periods stipulated, starting from the date of the substantial completion. Each warranty must be signed by an authorized representative of the issuing company.

D. Selection Samples: Two complete sets of samples, representing manufacturer's full range of available products, colors, textures, thicknesses and surfacing.

E. Verification Samples: For each product and finish specified, two samples representing actual products, colors, textures, thicknesses and surfacing.

F. FM Global Compliance: Certification that the roofing/waterproofing membrane meets FM Global Approval Standard 4470 for Class I roof covers, on non-combustible substrates, with a Class 1 documented wind uplift rating meeting the design requirements for the project, a hail rating of SH and an ASTM E-108-00 Class A approval at a slope of 1 in 12.

G. Florida Product Approvals: submit verification.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:

1. Membrane Manufacturer shall show evidence that the specified membrane has been manufactured by the same organization or direct affiliate for fifteen years.
2. Membrane Manufacturer shall have available an in-house technical staff to assist the contractor when necessary in the application of the products and site review of the assembly.

B. Installer's Qualifications: The Contractor shall demonstrate qualifications to perform the Work of this Section by submitting certification or license by the roofing/waterproofing membrane manufacturer as a trained and authorized applicator of the product the installer intends to use.

C. Source Limitations: All components listed in this section shall be provided by a single manufacturer or approved by the primary roofing/waterproofing manufacturer.

D. Materials Compatibility: All materials included in the roofing/waterproofing assembly, as well as associated materials adhered to/applied beneath the roofing/waterproofing membrane shall have been tested and verified to be compatible. Include written testing documentation and test reports if requested by Architect.

E. Final Inspection: Manufacturer's representative shall provide to the Architect a comprehensive site visit report after the completion of the roofing/waterproofing system

F. Applicable Regulations: Comply with local code and requirements of authorities having jurisdiction. Do not exceed VOC regulations as established by the State in which they are being installed; including total VOC content, in grams per liter, for all system components (i.e. primers, adhesives, coatings, and similar items).

G. Roofing Terminology: Refer to ASTM D1079 and the glossary of the National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual for definitions of roofing terms related to this section.

1.6 PRE-INSTALLATION CONFERENCE

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with University, Architect, University's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative,

deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver all roofing/waterproofing materials to the site in original containers, with factory seals intact.

B. Store all pail goods in their original undamaged containers in a clean, dry location within their specified temperature range.

C. Do not expose materials to moisture in any form before, during, or after delivery to the site. Reject delivery of materials that show evidence of contact with moisture.

D. Remove manufacturer supplied plastic covers from materials provided with such. Use “breathable” type covers such as canvas tarpaulins to allow venting and protection from weather and moisture. Cover and protect materials at the end of each work day. Do not remove any protective tarpaulins until immediately before the material will be installed.

E. Materials shall be stored above 55°F a minimum of 24 hours prior to application

1.8 PROJECT CONDITIONS

A. Weather: Proceed with roofing/waterproofing only when existing and forecasted weather conditions permit.

B. Membrane application shall be able to proceed when precipitation is imminent. Provide membrane that is capable of curing in immersion immediately after application.

1. Provide membrane where if visual marks in the form of pock marks may occur if uncured membrane is exposed to heavy rainfall, that shall not be considered a limiting factor in the performance of the roofing membrane.

2. Ambient temperatures shall be above 36°F when applying the roofing/waterproofing system.

C. All surfaces to receive the roofing/waterproofing membrane shall be free from visible water, dew, frost, snow and ice. Application of roofing/waterproofing membrane shall be conducted in well ventilated areas.

D. Roofing Membrane:

1. Roofing/waterproofing membrane is not intended to be exposed or in contact with a constant temperature below -22°F or in excess of 176°F. See manufacturer's technical data sheets for limitations, i.e., hot pipes and vents or direct steam venting.
2. Specified roofing/waterproofing membrane shall be non-flammable and VOC compliant.
3. Specified roofing/waterproofing membrane shall be resistant to gasoline, paraffin, fuel oil, mineral spirits, and moderate solutions of acids and alkalis, acid rain and detergents.
4. Any exposure to foreign materials or chemical discharges shall be presented to membrane manufacturer for evaluation to determine any impact on the waterproof membrane assembly performance prior to warranty issuance.

E. Temporary Protection:

1. Building components shall be protected adequately (with tarp or other suitable material) from soil, stains, or spills at hoisting points and area of application. Contractor shall be responsible for preventing damage from any operation under its contract. Any such damage shall be repaired at Contractor's expense to Owner's satisfaction or be restored to original condition.
2. Provide barricades, retaining ropes, safety elements (active/passive) and any appropriate signage required by OSHA, NIOSH, and NSC and/or the Owner or designated Representative.
3. Protect finished roofing/waterproofing membrane from damage by other trades. Do not allow waste products containing hydrocarbons such as petroleum, grease, acid, solvents, vegetable or mineral oil, animal oil or animal fat, or direct steam venting to come into direct contact with the membrane.

F. Specified roofing/waterproofing membrane may be used as a temporary roofing/waterproofing barrier when applied at a wet film thickness of 15-20 mils to a properly prepared deck. When the specified roofing/waterproofing membrane is used as a temporary roofing/waterproofing barrier the roofing/waterproofing membrane does not need to be removed prior to installation of the finished roofing/waterproofing system

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, substrate board, roofing accessories, and other components of membrane roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TWO COMPONENT POLYESTER ROOFING SYSTEM

A. Roofing System**:** Two-component, cold-fluid applied, reinforced polyurethane membrane for use in an adhered roofing system, with 360 degree needle punched non-woven 165 polyester reinforcing fleece, with a 80 mils thick dry film thickness. Comply with ASTM C 836 and with manufacturer's written physical requirements.

B. Manufacturer and Products: Provide one of the following or equal:

1. (Basis of Design) Kemper System America; KEMPEROL Reflect FR: highly reflective, fire rated roofing resin system. FL17442-R3.

2. Acceptable:

a. DURBIGUM Americas, Inc; Liquids EF Roofing and Waterproofing System.
b. Sika Corporation; Sikalastic RoofPro 20.

C. Physical Requirements:

1. Membrane shall comply with the following physical requirements:

a. Color: White to comply with SRI requirements for exposed installations.
b. VOC: 32 g/l
c. Elongation: Min 30%, ASTM D5147 / ASTM D412.
d. Tearing Strength: 90 lbf, ASTM D5147
e. Puncture Resistance: 56 lbs. ASTM D5602.
f. Dimensional Stability: 0.15% ASTM D1204 / ASTM D5147.
g. Water absorption: less than 1%, ASTM D570.
h. Impact Resistance: Shore A 75 +/- 5; ASTM D2240.
i. Water Vapor Transmission: 0.08 perms; ASTM E 96.
j. Crack spanning: 2 mm/ 0.08 inch.
k. Short term Temperature resistance: 482 deg F.

2.2 SUBSTRATE AND COVER BOARDS

A. Manufacturers and products: provide one of the following or equal:

1. (Basis of Design) Georgia Pacific; DensDeck Prime Roof Board.
2. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
3. USG Corporation; Securock Glass Mat Roof Board.

A. Adhesive: Two-component low-rise adhesive designed for anchoring acceptable roof insulation to acceptable substrates and to adhere multiple layers of insulation and coverboard.

2.3 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

B. General: Preformed roof insulation boards manufactured or approved by KEE membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

C. Manufacturers and products include the following or equal:

1. Atlas Roofing Corporation; Atlas Roof Insulations
2. GAF “GAF EnergyGuard:
3. RMax; Multi-Max
4. Seaman "Roof Insulation"
5. SIKA; Sarnatherm

D. Non-tapered insulation shall be a minimum of 4" thickness.

E. Roof insulation shall have an average thermal performance of R-20.

F. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

G. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.4 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

D. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

E. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.5 ROOF WALKWAY PADS

A. Walkway Pads: Membrane with slip-resisting surface texture, manufactured specifically for adhering to fluid-applied roofing as a protection course for foot traffic.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Provided by roof membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof drain bodies are securely clamped in place.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Substrate Acceptability: Inspect areas and accept surfaces designated to receive cold fluid applied roofing system, as satisfactory for the reception of the Work specified in this Section, without conflict with "Warranty" requirements. Commencement of installation shall constitute acceptance of substrate conditions by the Installer.

B. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Roughen all metal surfaces by grinding.

C. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.

D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION OF INSULATION

A. For insulated assemblies, install approved isocyanurate foam insulation/cover board to the structural deck, either with urethane foam adhesive or mechanical fasteners.

B. Loosely lay board insulation units over roofing membrane, with long joints of insulation in continuous straight lines and with end joints staggered between rows. Abut edges and ends between units.

C. Install one or more layers of insulation to achieve required thickness over roofing membrane. Cut and fit to within 3/4 inch of projections and penetrations.

1. Where overall insulation thickness is 2 inches or more, install required thickness in two or more layers with joints of each succeeding layer staggered over joints of previous layer a minimum of 6 inches in each direction.

3.4 ROOFING APPLICATION

A. Mix and apply primers, and cold fluid applied reinforced unsaturated polyester roofing system in strict compliance with the manufacturer's written instructions.

B. Start installing roofing in presence of manufacturer's technical representative.

C. Apply primer over properly prepared and approved substrate.

D. Reinforced Roofing Applications: Mix materials and apply roofing by roller, notched squeegee, trowel, or other suitable application method.

1. Apply first coat of roofing, embed membrane-reinforcing fabric, and apply second coat of roofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases, with an average dry film total thickness of 120 mils.
2. Apply reinforced roofing to prepared wall terminations and vertical surfaces.
3. At fleece seams, allow a 2 inch overlap for side joints and 4 inch overlap for end joints.
4. At membrane tie offs, clean in place membrane using manufacturer recommended solvents and allow solvents to fully evaporate before applying new resin.
5. Verify wet film thickness of roofing every 100 sq. ft.

E. Install flashing system in accordance with membrane manufacturer's recommendations and requirements. Provide system with base flashing, edge flashing, penetration flashing, counter flashing and flashing at other penetrations as required for a complete watertight system.

F. Install flashings before installing field membrane to minimize foot traffic over newly installed field membrane.

G. Install flashings concurrently with membrane as the work progresses. Do not use temporary flashings. Apply flashings to a vertical height of 8 inches for all flashing penetrations. Terminate flashings as required by membrane manufacturer.

H. Metal flashings: Comply with SMACNA recommendations, industry standards and membrane manufacturer's recommendations for application of metal flashings.

1. Provide metal flashing flanges minimum 4 inch long, secured to nailers with center staggered fasteners 6 inches on center. Overlay metal edges with membrane.
2. Apply primer, resin and fleece to metal flanges extending membrane to outside face of metal edging and vertical face of metal base/curb flashing.
3. Flash pipes, conduits and unusually shaped penetrations using two part assembly consisting of a vertical wrap and horizontal target patch. Provide a minimum of two inch overlap between vertical and horizontal flashing components.
4. Install clamping rings at drains and strainer basket to prevent debris from clogging drain lines.

3.5 FIELD QUALITY CONTROL

A. Manufacturer’s Field Services: Arrange for waterproofing system manufacturer's technical personnel to inspect work a minimum of 3 times during installation of system. Manufacturer’s representative’s inspection includes the following:

B. Substrate and surface preparation.

1. First application of waterproofing membrane, intermediate inspections as work progresses, and completed installation including membrane, flashings, protection, and drainage components.

C. Submit written reports of each inspection to Architect.

D. Testing Agency: Owner shall engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.

E. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

F. Additional inspections, at Owner's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Final Inspection: Arrange for manufacturer's representative to inspect completed roofing installation before covering with other construction and provide written report that installation complies with manufacturer's written instructions.

1. Remove and replace applications of roofing where inspection indicates that it does not comply with specified requirements.

3.6 CURING, PROTECTION, AND CLEANING

A. Cure roofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.

1. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect roofing from damage and wear during remainder of construction period.

C. Protect installed insulation from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Immediately after installation, provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075600

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sheet metal flashing and trim in the following categories:

1. Metal flashing: aluminum and steel.
2. Metal Coping.

B. Related Sections

1. Division 07 “Flexible Flashing.”
2. Division 07 "Ethylene Interpolymer (KEE) Roofing"
3. Division 07 “Fluid-Applied Roofing.”

1.3 PERFORMANCE REQUIREMENTS

A. Building Code Requirements: Provide sheet metal flashing and trim system that complies with the requirements of the Florida Building Code.

B. Exterior products in this section must have Florida Product Approvals.

C. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

B. Shop Drawings: Of each item specified showing layout, profiles, methods of joining, and anchorage details.

C. Samples: Of sheet metal flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.

1. 8-inch- square Samples of specified sheet materials to be exposed as finished surfaces.
2. 12-inch- long Samples of factory-fabricated products exposed as finished Work. Provide complete with specified factory finish.

1.5 INFORMATION SUBMITTALS

A. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Owners and other information specified.

1.6 QUALITY ASSURANCE

A. Quality Control Standard: Sheet Metal & Air Conditioning Contractor's National Association (SMACNA), latest edition, and the Building Code.

B. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Mockups: Prior to installing sheet metal flashing and trim, construct mockups indicated to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect one week in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Architect's approval of mockups before start of final unit of Work.
5. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.7 PROJECT CONDITIONS

A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 GENERAL

A. NOTE: There are two flashing types: stainless steel and aluminum with high performance coatings. The locations of each are as indicated on the drawings. All stainless steel flashing inside and outside corners shall be prefabricated, mitered and welded.

2.2 METALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:

1. Factory-Painted Aluminum Sheet with high performance coating, custom color to match curtain wall: ASTM B 209, 3003-H14, with a minimum thickness of 0.040 inch, unless otherwise indicated.
2. Extruded Aluminum: ASTM B 221, alloy 6063-T52, with a minimum thickness of 0.080 inch.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.

1. Finish: 2D (dull, cold rolled).
2. Surface: Smooth, flat.

C. At Equipment Curbs Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation, pre-painted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Smooth, flat and mill phosphatized for field painting.

2.3 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Fasteners: 300 Series stainless steel of type recommended by the manufacturer for applications indicated.

B. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."

C. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

2.4 FABRICATION, GENERAL

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Form exposed sheet metal Work that is without oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

D. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

E. Expansion Provisions: Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

F. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

G. Separate metal from non-compatible metal or corrosive substrates with self-adhering flashing material.

H. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

I. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.

1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.5 SHEET METAL FABRICATIONS

A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

B. Base Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch thick
2. Aluminum: 0.040-inch thick, minimum.
   a. Finish: High-performance organic finish.

C. Counterflashing: Refer to Division 07 “Roof Specialties.”

D. Flashing Receivers: Fabricate from the following materials:

1. Stainless Steel: 0.016 inch thick.
2. Aluminum: 0.032-inch thick, minimum.
   a. Finish: High-performance organic finish.

E. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch thick.

F. Roof-Drain Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.016 inch thick.

G. Drip Edges: Fabricate from the following materials:

1. Stainless Steel: 0.016 inch thick.
2. Aluminum: 0.032-inch thick, minimum.
   a. Finish: High-performance organic finish.

H. Equipment Support Flashing: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch (0.71 mm) thick

2.6 STAINLESS STEEL FINISHES

A. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.

1. Finish: 2D (dull, cold rolled).
2. Surface: Smooth, flat.

2.7 ALUMINUM FINISHES

A. General: Comply with Aluminum Association's (AA) "Designation System for Aluminum Finishes" for finish designations and application recommendations.

B. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color: As selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

1. Install exposed sheet metal Work that is without oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

B. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or

intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.

1. Use joint adhesive for nonmoving joints specified not to be soldered.

D. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

E. Separations: Separate metal from non-compatible metal or corrosive substrates using self-adhering flashing material.

F. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches and bed with sealant.

G. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Seal flashing to equipment support member.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION 076200

SECTION 076500 -- FLEXIBLE FLASHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Self-adhering, vapor-retarding, flexible flashing membranes designed for use around wall openings on above grade, vertical wall surfaces.

B. NOTE: flexible flashing type may vary depending on substrate. Flashing to be compatible with substrate and adjoining materials and building components.

C. Related Sections including but not limited to:

1. Division 06 “Sheathing.”
2. Division 06 “Miscellaneous Rough Carpentry.”
3. Division 07 “Modified Bituminous Sheet Air Barriers.”
4. Division 07 “TPO Membrane Roofing.”
5. Division 07 “Sheet Metal Flashing and Trim.”
6. Division 07 “Joint Sealants.”
7. Division 08 “Hollow Metal Doors and Frames.”

1.3 PERFORMANCE REQUIREMENTS

A. Connections to Adjacent Materials: Provide connections to prevent air leakage at the following locations:

1. Walls, including penetrations, ties and anchors.
2. Walls, windows, curtain walls or doors.
3. Different wall assemblies, and fixed openings within those assemblies.
4. Wall and roof connections.
5. Wall control and expansion joints.
6. Wall pipe and duct penetrations.
7. Wall expansion joints.

B. Separator Membrane: Between dissimilar materials requiring separation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, specifications, installation instructions, recommendations, and tested physical and performance properties of products.

B. Shop Drawings:

1. Show locations and extent of flexible membrane flashing. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
2. Include details of interfaces with other materials that form part of flashing.
3. Include 3-dimensionsal axonometric views of inside corners, outside corners, transitions and interfaces with other materials.

C. Samples: For the following products:

1. 12-by-12-inches square of each type of flashing membrane.
2. 12-by-12-inches square of each type of transition membrane.

1.5 INFORMATION SUBMITTALS

A. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of each type of flexible flashing membrane for compliance with requirements, based on comprehensive testing of current flashing formulations.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is authorized, approved, or licensed by flashing membrane manufacturer to install manufacturer's products.

B. Manufacturer Qualifications: A qualified manufacturer who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in installations with a record of successful in-service performance for a period of not less than 10 years.

C. Source Limitations: Obtain flashing materials, transition membranes, primers, adhesives, sealants, and other materials, through one source from a single manufacturer.

D. In-Place Mockups: Build mockups to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review flashing requirements and installation, special details, mockups, air leakage and bond testing, flashing protection, and work scheduling that covers flashings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by flashing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver prepackaged materials in manufacturer's original unopened packaging with labels intact. Packaging or containers shall fully identify brand, type, grade, class, and other qualifying information used to describe contents.

B. Storage:

1. Materials that are susceptible to retaining moisture or that may be damaged by moisture shall be stored in a dry location before application. Moisture-sensitive materials shall be stored in enclosed areas protected from moisture or elevated humidity.
2. Store membrane rolls lying down.
3. Stack materials on pallets or platforms that are raised off ground or substrate.
4. Cover materials in a manner to provide air circulation and to prevent damage to surfaces.
5. Store sealants, adhesives, and mastics at temperatures above 40 degrees F.
6. Store flammable materials in a cool dry area away from sparks and open flames. Follow precautions outlined on container or supplied by material manufacturer/supplier.
7. Materials determined by Design Consultant, and/or manufacturer's field representative to be damaged shall be removed from site and replaced at no cost to Owner.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.9 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

B. Coordination: Interface flashing work with adjacent and adjoining work to ensure best possible weather resistance and durability of completed flashing.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Apply flashing materials within the range of ambient and substrate temperatures recommended by flashing manufacturer. Do not apply flashings to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.

1. Protect substrates from environmental conditions that affect flashing performance.
2. Do not apply flashing to a damp or wet substrate or during snow, rain, fog, or mist.

B. Maintain adequate ventilation during application and curing of flashing materials.

PART 2 - PRODUCTS

2.1 BITUMINOUS FLEXIBLE FLASHING MEMBRANE

A. Flexible Flashing Membrane: 40-mil, self-adhesive flashing for cavity wall applications. Consisting of 32 mil of rubberized asphalt integrally bonded to an 8 mil, high-density, cross laminated polyethylene film.

1. Products: Provide one of the following or equal:

   a. Grace, W. R., & Co. - Conn.; Perm-A-Barrier Wall Flashing.
   b. Henry Company; Blueskin TWF.
   c. ExoAir 110/110LT

2. Physical and Performance Properties:

   a. Membrane Thickness: 30-mils.
   b. Film Thickness: 8 mils.
   c. Puncture Resistance: 80 lbf. minimum.
   d. Tear Resistance: 13 lbf. initiation per ASTM D 1004.
   e. Tensile Strength: 800 psi per ASTM D 412, Die C Modified.
   f. Low Temperature Flexibility: Minus 22 degrees F, per ASTM D 1970.

2.2 ACCESSORY MATERIALS

A. General: Accessory materials recommended by flashing manufacturer to produce a complete flashing assembly and compatible with primary flashing membrane.

B. Primer: Liquid primer recommended for substrate by flashing material manufacturer.

C. Counterflashing Strip: Same as Flexible Flashing Membrane.

D. Sheet Flashing: Refer to Division 07 Section "Sheet Metal Flashing and Trim."

E. Termination Mastic: Flashing manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

F. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

G. Adhesive and Tape: Flashing manufacturer's standard adhesive and pressure-sensitive adhesive tape.

H. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.64 mm thick, and Series 300 stainless-steel fasteners.

I. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft. density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

J. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by flashing manufacturer.
3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for flashing application.

B. Mask off adjoining surfaces to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16-inch.

G. Bridge and cover joints with overlapping modified bituminous strips.

H. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

I. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for flashing.

3.3 INSTALLATION

A. General: Install modified bituminous flashing and accessory materials according to flashing manufacturer's written instructions and according to recommendations in ASTM D 6135.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous flashing sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.

B. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.

1. Install modified bituminous strips centered over vertical inside corners. Install 3/4-inch fillets of termination mastic on horizontal inside corners.

C. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.

D. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by flashing sheet on same day. Reprime areas exposed for more than 24 hours.

E. Apply continuous modified bituminous sheets over modified bituminous strips bridging substrate cracks, construction, and contraction joints.

F. Seal top of flexible flashings to flashing sheet with an additional 6-inches- wide, counterflashing strip.

G. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

H. Install flashing sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous flashing.

I. Connect and seal exterior wall flashing membrane continuously to exterior glazing and window systems, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

J. Wall Openings: Prime concealed, perimeter frame surfaces of windows, and doors. Apply modified bituminous strip so that a minimum of 3-inches of coverage is achieved over each substrate. Maintain 3-inches of full contact over firm bearing to perimeter frames with not less than 1-inch of full contact.

1. Modified Bituminous Strip: Roll firmly to enhance adhesion.

K. Fill gaps in perimeter frame surfaces of windows, doors, and miscellaneous penetrations of flashing membrane with foam sealant.

L. At end of each working day, seal top edge of flashing material to substrate with termination mastic.

M. Apply joint sealants forming part of flashing assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.4 FIELD QUALITY CONTROL

A. Inspections: Flashing materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of flashing system has been achieved throughout the building envelope with no gaps or holes.
2. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
3. Site conditions for application temperature and dryness of substrates have been maintained.
4. Maximum exposure time of materials to UV deterioration has not been exceeded.
5. Surfaces have been primed.
6. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
7. Termination mastic has been applied on cut edges.
8. Flashing has been firmly adhered to substrate.
9. Compatible materials have been used.
10. Transitions at changes in direction and structural support at gaps have been provided.
11. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
12. All penetrations have been sealed.

3.5 CLEANING AND PROTECTION

A. Protect flashing system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect flashing from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace flashing or install additional, full-thickness, flashing application after repairing and preparing the overexposed membrane according to flashing manufacturer's written instructions.
2. Protect flashing from contact with incompatible materials and sealants not approved by flashing manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 072713

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Aluminum reglets and counterflashing.

B. Related Sections:

1. Division 07 Section "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
2. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
3. Division 07 “Roofing.”
4. Division 07 Section "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Florida Product Approvals Listing: Manufacture and install copings that are listed as Florida Product Approvals.

C. FM Approvals' Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.

D. SPRI Wind Design Standard: Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:

1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
3. Details of termination points and assemblies, including fixed points.
4. Details of special conditions.

C. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

1.5 INFORMATION SUBMITTALS

A. Informational LEED Submittals: Comply with Division One Section "Sustainable Design Requirements" for the following Building Product Disclosure and Optimizations:

1. Environmental Product Declarations.
2. Sourcing of Raw Materials.
3. Material Ingredient Optimization.
4. Product Manufacturer Supply Chain Optimization.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings.

C. Maintenance Data: For roofing specialties to include in maintenance manuals.

D. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

B. Preinstallation Conference: Conduct conference at Project site.

1. Meet with University, Architect, University's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. NOTE: All stainless steel counterflashing shall be shop-fabricated and mitered, with welded corners. Locations of aluminum and stainless are indicated on the drawings.

2.2 FABRICATORS/INSTALLERS

A. Available fabricators/installers offering products that may be incorporated into the Work include the following or equal:

1. Englert Inc, Tampa FL 5102 Causeway Blvd, Tampa, FL 33619-6128, (813) 248-2296, www.englertinc.com
2. Gene Dune, 500 Marlborough Street, Oldsmar, FL 34677, Tampa, FL (813) 855-7006http://www.genedunnguttering.com

2.3 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Fry Reglet Corporation (Basis of Design)
2. Cheney Flashing Company.
3. Heckmann Building Products Inc.
4. MM Systems Corporation.
5. Or equal.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

1. Stainless Steel: 0.025 inch thick.

2. Formed Aluminum: 0.050 inch thick.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:

1. Stainless Steel: 0.025 inch thick.

2. Formed Aluminum: 0.032 inch thick.

D. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Aluminum Finish: Two-coat fluoropolymer

2.4 EXPOSED METALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

1. Surface: Smooth, flat finish.
2. Mill Finish: As manufactured.
3. Color: Coordinate with color of metal panels.
4. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer (Kynar): AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
    b. Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.5 CONCEALED METALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

2.6 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29

3. Products: Provide one of the following or equal:

a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
c. Henry Company; Blueskin PE200 HT.

2.7 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

C. Elastomeric Sealant: ASTM C 920, elastomeric **silicone** polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

F. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

G. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

H. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

B. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment] [or] [polyethylene sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate and according to Manufacturer’s instructions. .

E. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.

C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

3.5 CLEANING AND PROTECTION

A. Clean off excess sealants.

B. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

C. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Roof hatches at Penthouse.

B. Related sections:

1. Division 05 "Metal Stairs" for Alternating Tread Device.
2. Division 07 " Roofing".
3. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing.
4. Division 07 Section "Roof Specialties" for counterflashing
5. Division 23 Sections for pre-manufactured equipment curbs.

1.3 PERFORMANCE REQUIREMENTS

A. Building Code Requirements: Provide roof accessories which comply with requirements of the Florida Building Code.

B. Exterior products in this section must have Florida Product Approval.

C. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.

C. LEED Informational Submittals: Comply with Division One Section "Sustainable Design Requirements" for the following Building Product Disclosure and Optimizations:

1. Environmental Product Declarations.
2. Sourcing of Raw Materials.
3. Material Ingredient Optimization.

4. Product Manufacturer Supply Chain Optimization.

D. Shop Drawings: Show fabrication and installation details. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other Work.

1. Anchoring system for equipment supports and roof hatches shall comply with the requirements of the Florida Building Code.

E. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances

1.5 INFORMATION SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

B. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Standards: Comply with the following:

1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

B. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

C. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29

3. Products: Provide one of the following or equal:

   a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
   b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
   c. Henry Company; Blueskin PE200 HT.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

F. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

G. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 ROOF HATCHES

A. Manufacturers: Provide products by one of the following or equal:

1. (Basis of Design) Babcock Davis
2. Bilco Company
3. JL Industries
4. Milcor, Inc.

B. Products (Basis of Design):

1. Location: Roof

   a. Model: Babcock Davis; BRHHA 30X54S1T
      1) NOA NO: 18-0110.05
   b. Access: Alternating Tread Device, refer to Division 05 "Metal Stairs" for requirements.
   c. Finish: Aluminum Mill Finish
   d. Size: 2'-6" x 4'-6"
   e. Curb Height: 12-inches.
   f. Accessories:
      1) Coordinating Keehatch Railing System
      2) Inside padlock hasp.

2.5 GENERAL FABRICATION REQUIREMENTS

A. General: Fabricate units to withstand 40-lbf/sq. ft. external loading and 20-lbf/sq. ft. internal loading pressure. Frame with 12-inch high, integral-curb, double-wall construction with 1-1/2 inch insulation, cant strips and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 1-inch insulation core. Provide gasketing and equip corrosion-resistant hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles. Provide heavy-duty frame mounted enclosed torsion spring design with opening assist.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
5. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weather tight.
6. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.
7. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated,

B. Separation: Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with permanent separation.

C. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

D. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

E. Roof Curb Installation: Install each roof curb so top surface is level.

F. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

G. Roof-Hatch Installation:

1. Install roof hatch so top surface of hatch curb is level.

2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
3. Attach safety railing system to roof-hatch curb.
4. Attach ladder-assist post according to manufacturer's written instructions.

H. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 painting Sections.

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Walls and partitions.
2. Floors, ceilings, and roofs.
3. Smoke barriers.

1.3 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing and non-load bearing walls, including partitions, with fire-protection-rated openings.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or US 1479, based on testing at a positive differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to US 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

F. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.4 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of through-penetration firestop system product indicated.

C. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

1.5 INFORMATION SUBMITTALS

A. Informational LEED Submittals: Comply with Division One Section "Sustainable Design Requirements" for the following Building Product Disclosure and Optimizations:

1. Environmental Product Declarations.
2. Sourcing of Raw Materials.
3. Material Ingredient Optimization.
4. Product Manufacturer Supply Chain Optimization.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience.

C. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

D. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Installer Qualifications: An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to an installer engaged by Contractor does not in itself confer qualification on buyer.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.

2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:.

a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the UL in "Fire Resistance Directory."

E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify University's inspecting agency at least seven days in advance of through-penetration firestop system installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until University's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regional Materials: Provide a minimum of 20 percent of building materials (by cost) that are regionally extracted, processed and manufactured materials within a radius of 500 miles.

B. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

   a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

      1) UL in its "Fire Resistance Directory."
      2) Intertek Group in its "Directory of Listed Building Products."
      3) FM Global in its "Building Materials Approval Guide."

C. Sealants: All sealants used in firestopping systems shall comply with ASTM G21 for a 0 rating for mold and mildew resistance.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Provide penetration firestopping systems that are produced and installed to resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Include both empty openings and openings containing penetrating items. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Provide products by one of the following or equal:

   a. 3M Fire Protection Products.
   b. Grace, WR & Co.
   c. Hilti, Inc.
   d. Johns Manville.
   e. Specified Technologies, Inc.

f. Thermafiber, Division Owens Corning.
g. Tremco, Inc.

2.3 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

   a. Slag-/rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.4 FILL MATERIALS

A. General: Provide through-penetration firestop systems containing the types of fill materials indicated by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.

B. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in other horizontal surfaces.
3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.5 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: At the start of the installation, periodically as the Work progresses, and after completion, furnish the services of the firestop material manufacturers’ technical representative at the job site as necessary to advise on every phase of the Work. As a minimum, furnish representative’s attendance during the first day of installation for each major type of firestop material, and furnish technical assistance to the Installer as may be required.

B. Owner's Inspecting Agency: Owner will engage a qualified independent inspection and testing agency to perform tests and inspections according to ASTM E2174 requirements including those related to qualifications, conducting inspections, preparing test reports. Owner's inspection agency shall monitor the Contractor's Quality Control program. Monitoring activities are at the Owner's discretion and shall in no way relieve the Contractor of sole responsibility for the Work.

1. Inspections of firestopping work shall comply with the local jurisdiction's Building Code "Special Inspections" statutory requirements for component materials and installation.

C. Inspections: Provide on-site inspections for fire stops in accordance with ASTM E2174, and on-site inspections for fire resistive joint systems and perimeter fire barriers in accordance with ASTM E2393 as the work progresses. Verify that firestopping systems have been constructed in compliance with the submitted designs for fire rating required by the Contract Documents and are acceptable to Authorities having jurisdiction. Do not proceed with installation of joint systems for the next area unit inspecting agency determines work shows compliance with requirements.

1. Visual inspection of substrates before installation of firestopping to ascertain that preparation has been performed in accordance with the Contract Documents.
2. Visual inspection of completed work including removal of damming materials if used to ensure an adequate and complete fire and smoke seal.
3. Final inspection after other trades have completed Work in contact with firestopping material, but before firestopping material is covered.

D. Remove and replace firestop systems where inspections indicate that they do not comply with specified requirements.

E. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

F. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove

damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire-resistive joint systems for the following:

1. Floor-to-floor joints.
2. Floor-to-wall joints.
3. Head-of-wall joints.
4. Wall-to-wall joints.
5. Joints between perimeter edge of fire-resistance-rated floor assemblies and back of non-fire-resistance-rated, exterior, glazed aluminum curtain walls.

1.3 PERFORMANCE REQUIREMENTS

A. General: For joints in the following constructions, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed:

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Fire-resistance-rated floor assemblies.
4. Exterior curtain-wall assemblies and fire-resistance-rated floor assemblies.

B. Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equaling or exceeding fire-resistance rating of constructions in which joints are located, as determined by UL 2079.

1. Load-bearing capabilities as determined by evaluation during the time test.

C. Fire Resistance of Perimeter Fire-Containment Systems: Integrity and insulation ratings indicated as determined by UBC Standard 26-9 and UL 2079.

D. Penetrations in Fire-Resistance Rated Walls: Penetration firestopping systems with ratings determined per ASM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-wg.
1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

E. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or US 1479, based on testing at a positive differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to US 1479.

F. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

1.4 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated.

C. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed and relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

1.5 INFORMATION SUBMITTALS

A. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.

B. Informational LEED Submittals: Comply with Division One Section "Sustainable Design Requirements" for the following Building Product Disclosure and Optimizations:

1. Environmental Product Declarations.
2. Sourcing of Raw Materials.
3. Material Ingredient Optimization.
4. Product Manufacturer Supply Chain Optimization.

C. Qualification Data: For Installer.

D. Compatibility and Adhesion Test Reports: From fire-resistive joint system manufacturer indicating the following:

1. Materials forming joint substrates have been tested for compatibility and adhesion with fill materials.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

E. Evaluation Reports: Evidence of fire-resistive joint systems' compliance with ICBO ES AC30, from the ICBO Evaluation Service.

F. Research/Evaluation Reports: For each type of fire-resistive joint system.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fire-resistive joint systems for each kind of joint and construction condition indicated through one source from a single manufacturer.

B. Preconstruction Compatibility and Adhesion Testing: Submit to fire-resistive joint system manufacturers, for testing indicated below, samples of materials that will contact or affect fill materials.

1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of fill materials to joint substrates.

   a. Perform tests under environmental conditions replicating those that will exist during installation.

2. Submit no fewer than nine pieces of each type of material, including joint substrates, forming materials, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain fire-resistive joint system manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

C. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per ICBO ES AC30 and are qualified for types of joints and joint movement capabilities indicated in a current Evaluation Report by the ICBO Evaluation Service.

3. Fire-resistive joint systems are identical to those tested per UL 2079. Provide rated systems complying with the following requirements:

   a. Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.

   b. Fire-resistive joint systems correspond to those indicated by referencing system designations listed by the UL in its "Fire Resistance Directory."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify University's inspecting agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until University's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS, GENERAL

A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

B. Accessories: Provide components of fire-resistive joint systems, including forming materials that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

C. Where UL-classified fire-resistive joint systems are indicated, they refer to alphanumeric designations listed in UL's "Fire Resistance Directory" under product Category XHBN.

D. Where UL-classified perimeter fire-containment systems are indicated, they refer to alphanumeric designations listed in UL's "Fire Resistance Directory" under product Category XHDG.

2.2 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or equal:

   a. 3M Fire Protection Products.
   b. Hilti
   c. Tremco, Inc.; Tremco Fire Protection Systems Group.
   d. USG Corporation.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or equal:

   a. Hilti, Inc.
   b. Thermafiber, Inc.
   c. USG Corporation.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or equal:

   a. Hilti, Inc.
   b. STI Firestop.
   c. USG Corporation.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.

B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Inspecting Agency: University will engage a qualified independent inspecting agency to inspect fire-resistive joint systems and to prepare inspection reports.

1. Inspecting agency will state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

B. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and inspecting agency has approved installed fire-resistive joint systems.

C. If deficiencies are found, repair or replace fire-resistive joint systems so they comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.6 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

A. Designation System for Joints in or between Fire-Resistance-Rated Constructions: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHBN.

B. Floor-to-Wall Fire-Resistive Joint Systems FRJS-1:

1. Available UL-Classified Systems: FW-D-0000-0999.
2. Assembly Rating: 2 hours.
3. Nominal Joint Width: As indicated, but less than or equal to 2 inches, maximum.
4.
5. Movement Capabilities: Class II - 25 percent compression or extension.

C. Head-of-Wall Fire-Resistive Joint Systems FRJS-2:

1. Available UL-Classified Systems: HW-D-0000-0999.
2. Assembly Rating: 2 hours, unless otherwise indicated.
3. Nominal Joint Width: As indicated, but less than or equal to 2 inches, maximum.

4. Movement Capabilities: Class II - 25 percent compression or extension, unless otherwise indicated on Drawings.

D. Wall-to-Wall Fire-Resistive Joint Systems FRJS-3:

1. Available UL-Classified Systems: WW-D-0000-0999.
2. Assembly Rating: 2 hours, unless otherwise indicated.
3. Nominal Joint Width: As indicated, but less than or equal to 2 inches, maximum.
4. Movement Capabilities: Class II - 25 percent compression or extension.

E. Perimeter Fire-Resistive Joint Systems PFRJS-4:

1. Available System: Safing Insulation and Joint Coating.

a. Fire-Resistance Rating: 2 hours.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Solvent-release-curing joint sealants.
5. Preformed joint sealants.
6. Acoustical joint sealants.

B. Exterior Joints in Vertical Surfaces and Horizontal Non-traffic Surfaces:

1. Construction joints in cast-in-place concrete.
2. Control and expansion joints in unit masonry.
3. Joints between different materials listed above.
4. Perimeter joints around frames of doors, windows and louvers.
5. Control and expansion joints in overhead surfaces.

C. Exterior Joints in Horizontal Traffic Surfaces:

1. Joints between different materials listed above.

D. Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:

1. Control and expansion joints on exposed interior surfaces of exterior walls.
2. Perimeter joints of exterior openings.
3. Vertical joints on exposed surfaces of interior unit masonry.
4. Perimeter joints between interior wall surfaces and frames of interior doors and elevator entrances.
5. Joints between plumbing fixtures and adjoining walls, floors, and counters.

E. Interior Joints in Horizontal Traffic Surfaces:

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing:

1. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for

adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. University requires testing for sealants for porous, light colored materials and metal panel substrates which indicate level of residue rundown and substrate staining.

1. Test requires 22 days and upon successful completion, lab provides 20 year non-staining warranty.

C. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:

a. Each kind of sealant and joint substrate indicated.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each joint-sealant product indicated.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATION SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

E. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

G. Field-Adhesion Test Reports: For each sealant application tested.

H. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

E. Pre-installation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Coordinate the products and manufacturers with the Schedule of Joint Sealants in Part 3.

B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Metal to metal or Window/louvers to Masonry: Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. Dow Corning Corporation; 795 (Basis of Design)
b. Tremco Incorporated; Spectrum 2.
c. Pecora 895.

B. Light colored metal panels or other light colored porous materials: Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT -- Exterior joints in porous vertical surfaces.

1. Products: Provide the following:

a. Dow Corning Corporation; 756 SMS or equal.

C. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. GE Advanced Materials - Silicones; Sanitary SCS1700.
b. Dow Corning Corporation; 786 Mildew Resistant.
c. Tremco Incorporated; Tremsil 200 Sanitary.

D. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following or equal:
a. Bostik, Inc.; Chem-Calk 500.
b. Tremco Incorporated; Vulkem 227.
c. Pecora; Dynatred.

E. Joints occurring between concrete block to block and concrete block to poured in place concrete: Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. Sika Corporation; Sika Flex 2C

b. Sonneborn: Sonneborn NP-2
c. Tremco Incorporated; Dymeric 240.

2.3 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. BASF Building Systems; Sonolac.
b. Bostik, Inc.; Chem-Calk 600.
c. Pecora Corporation; AC-20+.
d. Tremco Incorporated; Tremflex 834.

2.4 SOLVENT-RELEASE-CURING JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. Bostik, Inc.; Chem-Calk 300.
b. Pecora Corporation; BC-158.
c. Tremco Incorporated; Tremco Butyl Sealant.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. Pecora Corporation; AC-20 FTR.
b. USG Corporation; SHEETROCK Acoustical Sealant.
c. Tremco; Acoustical Sealant

2.6 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application

indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Stucco.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

    1. Do not leave gaps between ends of sealant backings.
    2. Do not stretch, twist, puncture, or tear sealant backings.
    3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

    1. Place sealants so they directly contact and fully wet joint substrates.
    2. Completely fill recesses in each joint configuration.
    3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.
    b. Whether sealant dimensions and configurations comply with specified requirements.
    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory.

Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. See table on following pages. Available and basis of design manufacturers and products listed in Part 2.

TYPE	Polymer	EXPOSURE/TRAFFIC	USES/APPLICATION
Elastomeric	Silicone Dow 795	Exterior joints in vertical surfaces and non-traffic horizontal surfaces	• Control joints in cast-in-place concrete and unit masonry assemblies. • Control joints in Portland Cement Stucco • Joints between materials listed above and frames of doors and windows • Aluminum windows and curtain walls and between windows and other materials. • Metal Panels • Other joints as indicated
Elastomeric	Silicone Dow 756 SMS	Exterior joints in porous vertical surfaces	• Joints between materials listed above and frames of doors and windows
Elastomeric	Multicomponent Urethane	Exterior joints in horizontal traffic surfaces	• Control, expansion, and isolation joints in cast-in-place concrete slabs • Other joints as indicated
Elastomeric	Silicone	Interior moving joints in vertical surfaces	• Control and expansion joints in exposed interior surfaces of exterior walls • Perimeter joints of exterior openings where indicated • Joints between top of non-load bearing unit masonry walls and underside of cast-in-place concrete slabs & beams • Tile control and expansion joints • Vertical control joints in exposed surfaces of interior unit masonry and concrete wall partitions • Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances
Elastomeric	Mildew-Resistant Silicone	Interior wet areas	• Wet areas around bathrooms • Wet areas around sinks
Elastomeric	Multicomponent Urethane	Interior horizontal traffic joints	• Paving and flooring control joints
Solvent Release Sealants	Butyl Sealant	Interior or concealed exterior	• Concealed sheet metal joints • Sealing Thresholds
Latex	Acrylic Latex Sealants	Interior	• Interior non-moving exposed sealants in gypsum drywall construction
Tape		Exterior or interior	• Interior or exterior concealed sealants in sheet metal construction
Acoustical		Interior	• Interior sealants in acoustical construction

END OF SECTION 079200

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section “Integrated Door Opening Assemblies”.
3. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
4. Division 08 Section "Door Hardware".
5. Division 08 Section "Access Control Hardware".
6. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
7. Division 28 Section "Access Control Hardware".
8. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access control system.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ANSI/SDI A250.13 - Testing and Rating of Severe Windstorm Resistant Components for Swing Door Assemblies.
7. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
9. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

10. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
11. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Doors Under Specified Pressure Differences Across the Specimens.
12. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
13. ASTM E1886 - Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
14. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes.
15. ANSI/NAAMM/HMMA 867-06 - Guide Specifications for Commercial Laminated Core Hollow Metal Doors and Frames.
16. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
17. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
18. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
19. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
20. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
21. TAS-201-94 - Impact Test Procedures.
22. TAS-202-94 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components using Uniform Static Air Pressure.
23. TAS-203-94 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.
24. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
25. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

C. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of anchorages, joints, field splices, and connections.
6. Details of accessories.
7. Details of moldings, removable stops, and glazing.
8. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Verification:

1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

E. Informational Submittals:

1. Hurricane Resistant Openings (State of Florida): Within the State of Florida, provide copy of current State of Florida Product Approval or Metro-Dade County Notice of Acceptance (NOA) as proof of compliance that doors, frames and hardware for exterior opening assemblies have been tested and approved for use at the wind load and design pressure level requirements specified for the Project.

    a. Hurricane Resistant Components (State of Florida): Within the State of Florida, provide copy of independent, third party certified listing conforming to ANSI A250.13.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40” above sill) or UL 10C.

1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
3. Smoke Control Door Assemblies: Comply with NFPA 105.

    a. Smoke "S" Label: Doors to bear “S” label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

E. Hurricane Resistant Exterior Openings (State of Florida including High Velocity Hurricane Zone (HVHZ): Provide exterior hollow metal doors and frames as complete and tested assemblies, or component assemblies, including approved hardware specified under Section 087100 "Door Hardware", to meet the wind loads, design pressures, debris impact resistance, and glass and glazing requirements as detailed in the current State of Florida building code sections applicable to the Project.

1. Each unit to bear third party permanent label in accordance with Florida Building Code requirements.

F. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. MATERIALS ARE SPECIFIED IN ACCORDANCE WITH THE PREMIER/ASSA ABLOY GPO CONTRACT #PP-FA-663.

B. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:

1. CECO Door Products (C).
2. Curries Company (CU).
3. Pioneer Industries (PI).
4. Steelcraft (S).

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.

1. Design: Flush panel.
2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 “Laminated Core”.

    a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
    b. Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel.

    a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

2. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2.
3. Vertical Edges: Vertical edges to have the face sheets joined by a continuous weld extending the full height of the door. Welds are to be ground, filled and dressed smooth. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

1. Curries Company (CU) - Polystyrene Core - 707 Series.
2. Curries Company (CU) - Energy Efficient - 777 Trio-E Series.

2.4 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufacturers Basis of Design:

a. Curries Company (CU) – M Series.

C. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufacturers Basis of Design:

a. Curries Company (CU) - M Series.

D. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
3. Windstorm Opening Anchors: Types as tested and required for indicated wall types to meet specified wind load design criteria.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LOUVERS

A. Metal Louvers: Unless otherwise indicated provide louvers to meet the following requirements.

1. Blade Type: Vision proof inverted V or inverted Y.
2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.

1. Manufacturers: Subject to compliance with requirements, provide louvers to meet rating indicated.
2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

2.7 LIGHT OPENINGS AND GLAZING

A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator’s shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.

C. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.8 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.9 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:

1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".

D. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

    a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
5. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
6. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
7. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".

    a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
    b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
    c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".

d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.

8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
9. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

c. Severe Storm Shelter Openings: Provide jamb, head, and sill anchors in accordance with manufacturer’s tested and approved assemblies.

10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
11. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.10 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Solid-core doors with ~~wood-veneer~~**MDO** faces **for painted finish**.
2. Factory ~~finishing~~ **priming solid core** flush wood doors.
3. Factory machining for hardware.

B. Related Sections include the following:

1. Division 01 Section "Sustainable Design Requirements".
2. Division 08 Section "Door Hardware" for door hardware for flush wood doors.
3. Division 08 Section "Glazing" for glass view panels in flush wood doors.
4. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.
5. Division 28 Sections for coordination with security system requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door and pocket door frame. Include details of core and edge construction, and trim for openings. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of cutouts.
2. Indicate doors to be factory finished and finish requirements.
3. Indicate fire ratings for fire doors.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. ~~For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.~~

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

B. Quality Standard: Comply with NWWDA I.S.1-A, "Architectural Wood Flush Doors." AWI's "Architectural Woodwork Quality Standards Illustrated."

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 and UL10C – Positive Pressure Testing that are listed and labeled by a qualified testing agency, for fire protection ratings indicated.

1. Provide Category “A” doors at all fire rated locations.
2. Doors in smoke barriers or exit enclosures shall also comply with UL1784 and bear an “S” label. These doors shall also meet the requirements for a 450 degree temperature rise door.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials or workmanship, have warped (bow, cup, or twist), or show telegraphing of core construction in face veneers.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

2. Warranty shall be in effect during the following period of time from date of Substantial Completion:

a. Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: provide products by one of the manufacturers listed below or equal:

1. Flush Wood Doors:

   a. Algoma Hardwoods Inc.
   b. Eggers Industries; Architectural Door Division.
   c. Marshfield Door Systems
   d. Doormerica, Division of ABS Manufacturing
   e. VT Industries

2.2 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

B. Flush Wood Doors:
   1. Grade: Custom
   2. Face Material: Medium-Density Overlay (Paint Grade Molded Composite).
   3. Location: Refer to Door Schedule for location.
   4. Stiles: Hardwood.
   5. Construction: 5 Ply

2.3 SOLID-CORE DOORS

A. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-1, made with binder containing no urea-formaldehyde resin].
2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

   a. 5-inch top-rail blocking.
   b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
   c. 5-inch midrail blocking, in doors indicated to have exit devices.

B. Fire-Rated Doors:

1. Construction: Construction and core specified above for type of face indicated or manufacturer's standard mineral-core construction as needed to provide fire rating indicated.

   a. Provide metal label on all fire-rated doors.

2. Blocking: For mineral-core doors, provide composite blocking with improved screw-holding capability approved for use in doors of fire ratings indicated as needed to eliminate through-bolting hardware.

3. Edge Construction: At hinge stiles, provide manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance and with outer stile matching face veneer.
4. Pairs: Provide fire-rated pairs with fire-retardant stiles matching face veneer that are labeled and listed for kinds of applications indicated without formed-steel edges and astragals.

2.4 LIGHT FRAMES

A. Metal Frames for Light Openings in Fire Doors: Manufacturer's standard frame formed of 0.0478-inch- thick, cold-rolled steel sheet; factory primed and approved for use in doors of fire rating indicated.

1. Jamb: Split jamb with zinc coated steel sides and back.

2.5 FABRICATION

A. General: Fabricate doors in sizes indicated for Project-site fitting.

1. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:

B. Clearances: Additional means of gap covering shall be provided where either code required or the room use dictates privacy.

1. Fire-Rated Doors: As required by NFPA 80.
2. Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, and not more than 1/8 inch between meeting stiles of pairs of doors; 3/4 inch at bottom unless otherwise indicated.

C. Machining: Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Pre-machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2.6 FACTORY FINISHING

A. General: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated" for factory finishing.

1. Finish doors at factory.

2. Doors are to be factory primed for paint all six sides.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Manufacturer's Written Instructions: Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.

1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold.

   a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
3. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Re-hang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 -- ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wall access doors and frames.
2. Fire-rated wall access doors and frames.
3. Ceiling access doors and frames.
4. Fire-rated ceiling access doors and frames.
5. GFRG access panels in gypsum board ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.

B. Shop Drawings: Show fabrication and installation details of customized doors and frames. Include plans, elevations, sections, details, and attachments to other Work.

1. Provide floor plans or reflected ceiling plans to show proposed location of access doors.

C. Schedule: Provide complete door and frame schedule, including types, general locations, sizes, construction details, finishes, latching or locking provisions, and other data pertinent to installation.

D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items with concealed framing, suspension systems, piping, ductwork, and other construction. Show the following:

1. Method of attaching door frames to surrounding construction.

2. Ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim.

1.4 INFORMATION SUBMITTALS

A. Maintenance Data: For access doors and frames to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain doors and frames through one source from a single manufacturer.

B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to Design Professional :

1. UL 10B for vertical access doors.
2. UL 263 for horizontal access doors and frames.

C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.6 COORDINATION

A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

B. Inserts and Anchoring Devices: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Access Doors:

   a. Larsen's Manufacturing Company.
   b. Milcor Limited Partnership.
   c. Nystrom Building Products Co.
   d. Windlock.
   e. Or equal.

2.2 ACCESS DOORS AND FRAMES

A. Glass Fiber Reinforced Gypsum Access Panel

1. (Basis of Design) Windlock Stealth.
~~1.~~2. Locations: Gypsum board ceilings in Restrooms, locker rooms, lobbies and as indicated.
~~2.~~3. Materials: prefabricated with high-density gypsum, reinforced with continuous random filament glass fiber mat and structural reinforcing.
   a. Glass Content: 5 to 6 percent by weight
   b. Density: 103 to 112 pcf
   c. Shell Thickness: 1/8 to 3/16 inch (3 to 5 mm) nominal
   d. Flammability: Flame Spread Index of 0 Smoke Development Index of 0
   e. Flexural Strength: 300-4000 PSI

f. Compressive Strength: 7600 PSI
g. Hardness (Barcol) 50
h. Impact Resistance 8.0 ft.-lb./in.2

B. Flush, Insulated, Fire-Rated Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.

1. Locations: Masonry, ceramic-tile wall and ceiling surfaces.
2. Fire-Resistance Rating: One and one-half hours.
3. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036-inch.
5. Frame: Minimum 0.060-inch thick sheet metal with 1-inch wide, surface-mounted trim.
6. Hinges: Continuous piano hinge.
7. Automatic Closer: Spring type.
8. Latch: Self-latching bolt operated by key with interior release.

C. Flush, Insulated, Fire-Rated Access Doors and Trimless Frames: Fabricated from steel sheet.

1. Locations: Gypsum board wall and ceiling surfaces.
2. Fire-Resistance Rating: One and one-half hours.
3. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036-inch.
5. Frame: Minimum 0.060-inch thick sheet metal with drywall bead.
6. Hinges: Continuous piano hinge.
7. Automatic Closer: Spring type.
8. Latch: Self-latching bolt operated by key with interior release.

D. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.

1. Locations: Masonry, ceramic-tile wall and ceiling surfaces.
2. Door: Minimum 0.060-inch thick sheet metal, set flush with exposed face flange of frame.
3. Frame: Minimum 0.060-inch thick sheet metal with 1-inch wide, surface-mounted trim.
4. Hinges: Continuous piano hinge.
5. Latch: Screwdriver operated cam latch.

E. Flush Access Doors and Trimless Frames: Fabricated from steel sheet.

1. Locations: Gypsum board wall and ceiling surfaces.
2. Door: Minimum 0.060-inch thick sheet metal, set flush with surrounding finish surfaces.
3. Frame: Minimum 0.060-inch thick sheet metal with drywall bead.
4. Hinges: Continuous piano hinge.
5. Latch: Screwdriver operated cam latch.

2.3 FABRICATION

A. General: Provide access door assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.

1. Exposed Flanges: Nominal 1-inch wide around perimeter of frame.
2. For trimless frames with drywall bead for installation in gypsum board assembly, provide edge trim for gypsum board securely attached to perimeter of frames.
3. Provide mounting holes in frames to attach frames to metal or wood framing in plaster and drywall construction and to attach masonry anchors in masonry construction. Furnish adjustable metal masonry anchors.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder lock, furnish two keys per lock and key all locks alike.

2.4 STEEL MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591/A 591M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.5 PAINT

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.7 STEEL FINISHES

A. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

B. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.

C. Apply shop primer to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

C. Install access doors with trimless frames flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

SECTION 083313 COILING COUNTER DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of overhead coiling doors:

1. Fire-rated Coiling counter doors at transaction counter at Chemical Storage Room.

B. Related Requirements:

1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
2. Division 09 Section "Interior Painting" for finish painting of factory-primed doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. For fire-rated doors, description of fire-release system including testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required.

1.4 INFORMATION SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Temperature-Rise Limit: At exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

3. Smoke Control: In corridors and smoke barriers, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10-inch wg for both ambient and elevated temperature tests.

PART 2 - PRODUCTS

2.1 COUNTER-TYPE FIRE-RATED DOOR

A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.

B. Manufacturers providing products in compliance with requirements include:

1. CornellCookson
2. McKeon
3. Overhead Door
4. Or equal.

2.2 COUNTER-TYPE FIRE-RATED DOOR

A. Product Characteristics:

1. Counter-type, push-up type.
2. Fire-rated door for one hour-rated wall.
3. Door shall have fusible link and shall not be tied to the fire alarm.

4. Dimensions:
   a. Opening size: 4 ft wide, 4 feet high.
   b. Counter at 36” AFF – 12 inches wide.
5. Door will expand upward in a fire.
6. For location: see drawings.

2.3 COUNTER DOORS

A. Integral Frame, Hood, and Fascia for Counter Door: Welded sheet metal assembly of the following sheet metal:

   1. Baked-Enamel or Powder-Coated Finish: White finish to match walls.

B. Integral Metal Sill for Counter Door: Fabricate sills as integral part of frame assembly of Type 304 stainless steel in manufacturer's standard thickness with No. 4 finish.

2.4 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   1. Run grain of directional finishes with long dimension of each piece.
   2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coiling counter doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install coiling counter doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Fire-Rated Doors: Install according to NFPA 80.

D. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

END OF SECTION 083313

`SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of overhead coiling doors:

1. Exterior Doors: Insulated service doors; motor operated.
2. Exterior Doors: Insulated service doors; manual.

B. Related Sections:
1. Division 08 Section “Coiling Fire and Smoke Rated Doors (Vertical) “
2. Division 08 Section “Coiling Counter Doors “
3. Division 08 Section “Overhead Coiling Grilles “

1.3 PERFORMANCE REQUIREMENTS

A. Building Code Requirements: Provide exterior overhead coiling doors which comply with requirements of the Florida Building Code.

B. Exterior products in this section must have Florida Product Approval.

C. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:

1. Wind Load: As indicated on drawings.

D. Operation-Cycle Requirements: Design overhead coiling door components and operator to operate for not less than 20,000 cycles.

1.4 ACTION SUBMITTALS

A. Florida Product Approval: Submit current Florida Product Approval in accordance with the Florida Building Code for the following:

B. Product Data: For each type and size of overhead coiling door and accessory. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide roughing-in diagrams, operating instructions, and maintenance information. Include the following:

1. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.
2. Summary of forces and loads on walls and jambs.
3. Motors: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.
4. Fire-Rated Doors: Information describing fire-release system, including testing and resetting instructions.

C. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's data sheets.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring and between components provided by door manufacturer and those provided by others.

D. Engineering Responsibility: Prepare engineering data for overhead coiling doors, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project signed and sealed by a professional engineer registered in the state of Florida.

1.5 INFORMATION SUBMITTALS

A. Testing and Labeling: Comply with the Florida Building Code. Submit manufacturer’s certification indicating compliance.

B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied finishes.

C. Samples for Verification: Of each type of exposed finish required, prepared on Samples of size indicated below and of same thickness and material indicated for Work. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.

1. Curtain Slats: 12-inch length.
2. Bottom Bar: 6-inch length.
3. Guides: 6-inch length.
4. Brackets: 6 inches square.
5. Hood: 6 inches square.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the overhead coiling door manufacturer for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.

1. Obtain operators and controls from the overhead coiling door manufacturer.

PART 2 - PRODUCTS

2.1 OVERHEAD COILING DOORS

A. Manufacturers: Subject to compliance with requirements, Acceptable Manufacturers include but are not limited to:

1. CooksonCornell Company (Basis of Design).
2. McKeon
3. Overhead Door Corporation
4. Or equal.

B. Product: Insulated Overhead Coiling Doors:

1. Motor Operated: Cornell Cookson, "Florida B" or equal.
   a. Florida Product Approval No: FL14636-R5
   b. Location and size: Refer to drawings.

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtain: Fabricate overhead coiling door curtain of interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Structural-quality, cold-rolled galvanized steel sheets complying with ASTM A 653, with G90 zinc coating.
2. At exterior conditioned dock Door Curtain Insulation: Fill slats for insulated doors at manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.

B. Endlocks for Service Doors: Malleable-iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets, or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Windlocks: Malleable-iron castings secured to curtain slats with galvanized rivets or high-strength nylon, as required to comply with wind load.

D. Bottom Bar: Manufacturer's standard continuous channel or tubular shape of same material as curtain slats.

1. Astragal: Provide a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene, between angles.
2. Provide motor-operated doors with combination bottom astragal and sensor edge.

E. Curtain Jamb Guides for Service Doors: Fabricate curtain jamb guides of steel angles, or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Build up units with not less than 3/16-inch- thick, galvanized steel sections complying with ASTM A 36, and ASTM A 123. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain and a continuous bar for holding windlocks.

2.3 HOODS AND ACCESSORIES

A. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.

1. Fabricate steel hoods, for steel doors, of not less than 0.028-inch thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653.
2. Include automatic drop baffle to guard against passage of smoke or flame.
3. Shape: Round.

B. Weatherseals: Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted to bottom and at top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of curtain coil hood.

1. Provide motor-operated doors with combination bottom weatherseal and sensor edge.
2. In addition, provide replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.

2.4 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of adjustable-tension steel helical torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast-steel barrel plugs to secure ends of springs to barrel and shaft.

D. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Provide mounting brackets of manufacturer's standard design, either cast-iron or cold-rolled steel plate with bell-mouth guide groove for curtain.

2.5 STEEL AND GALVANIZED STEEL FINISHES

A. Galvanized Steel: Phosphate treatment followed by baked-on polyester powder coat; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better.

1. Color: Color sample to be provided by Architect.

2.6 ELECTRIC DOOR OPERATORS

A. Door Operator: Industrial duty, UL listed, belt drive type jackshaft type operator(s).

1. Provide UL listed electric door operator assembly of size and capacity recommended by door manufacturer; complete with electric motor and factory pre-wired motor controls, positive locking mechanical brake, emergency manual chain hoist, and control station.
2. Motor shall be high starting torque, continuous duty, industrial type, protected against overload by a current sensing or thermal overload device. Primary speed reduction shall be heavy-duty 5L V-belt and sprocket double reduced secondary providing mechanical braking to hold the door in any position. Operator shall be equipped with an adjustable friction clutch and floor level disconnect and emergency manual hoist assembly, output and door driven sprocket shall be provided with the operator. Operator shall be capable of driving the door at a speed of 8 to 9 inches per second (20 to 23 cm/sec). Fully adjustable, driven linear type limit switch mechanism shall synchronize the operator with the door. Low friction nylon limit nuts fitted on threaded steel shaft, rotating on oilite self-lubricating bronze bushings. The motor shall be removable without affecting the limit switch settings.

B. Disconnect Device: Provide hand-operated disconnect or mechanism for automatically engaging lift mechanism operator and releasing brake for emergency manual operation while disconnecting motor, without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

C. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.

D. Remote-Control Station: Provide momentary-contact, 3-button control station with push-button controls labeled "Open," "Close," and "Stop."

1. Provide exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

E. Weather/Sensing Edge: Provide automatic reversing control by an automatic sensing switch within neoprene or rubber astragal extending full width of door bottom bar.

1. Provide self-monitoring sensing edge system. Contact with rubber profile will interrupt a contained infrared light beam, signaling the door operator to immediately stop downward travel and reverse direction to the fully opened position. Supervised system alters normal door operation preventing damage, injury or death due to an inoperable sensing edge system.

F. Limit Switches: Provide adjustable switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

G. Provide electric operators with ADA-compliant audible alarm and visual indicator lights.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.

3.2 ADJUSTING

A. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and fitting weather tight for entire perimeter.

3.3 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Test door closing when activated by detector or alarm connected fire-release system. Reset door-closing mechanism after successful test.

2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance, and procedures for testing and resetting release devices.
3. Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 083323

SECTION 084113 -- ALUMINUM-FRAMED ENTRANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior manual-swing aluminum doors.
2. Exterior aluminum door frames.
3. Incorporate security system components into the door and frame openings of all aluminum-framed entrances.

B. Related Sections include the following:

1. Division 07 Section "Sheet Metal Flashing and Trim" for flashing field installed with aluminum-framed entrances.
2. Division 07 Section "Joint Sealants" for installation of joint sealants installed with aluminum-framed entrances and for sealants to the extent not specified in this Section.
3. Division 08 Section "Door Hardware" for door hardware installed with aluminum-framed entrances.
4. Division 08 Section "Automatic Door Hardware" for automatic door hardware installed with glazed aluminum curtain wall systems.
5. Division 08 “Glazed Aluminum Windows and Curtain Walls” for manufacturers and other requirements.
6. ”Division 08 Section "Glazing" for insulating-glass requirements.
7. Division 28 Section "Security Systems, General" for security system components installed with glazed window wall systems.

C. Single Subcontract Responsibilities: Refer to Division 08 Section "Glazed Aluminum Curtain Walls" for the requirements of single subcontract responsibilities for aluminum-framed entrances.

1.3 STANDARDS

A. Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

1.4 PERFORMANCE REQUIREMENTS

A. General: Refer to Division 08 Section "Glazed Aluminum Curtain Walls", for fabrication and erection standards, provision for thermal and building movements, structural properties, and glass statistical factors; in addition provide the following:

1. Design and fabricate entrances to withstand the operating loads which result from heavy traffic conditions using the specified hardware, without measurable permanent deflection. Limit elastic deflections so as to provide the normal degree of rigidity required to avoid glass breakage, air leaks and other objectionable results of excessive flexibility. Provide weatherstripping at stiles, sill and head rails of door leaves, to minimize air, water and sound leaks.

1.5 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Control Approval: Submit current Product Control Notice of Acceptance in accordance with the Florida Building Code.

C. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated. Provide manufacturer’s specifications and installation instructions for each door and frame.

D. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of aluminum-framed entrances. Show scaled elevations, plans, and sections of the entire aluminum-framed entrances assemblies work. Provide full scale sections for details of the wall assemblies that cannot be shown in the elevations or sections. Indicate metal thickness of all metal components, glass thicknesses, metal finishes, and all other information necessary or requested by the Architect to indicate compliance with the Contract Documents. Details of field connections and anchorage and their relationship to the work of others shall be clearly indicated for the coordination of the work by other building trades. Details of fastening and sealing methods and product joinery shall be shown to ensure proper performances of the field installation. No work shall be fabricated until shop drawings for that work have been approved by the Architect for fabrication.

A. Engineering Responsibility: Prepare engineering data for exterior steel doors and frames including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project signed and sealed by a professional engineer registered in the state of Florida.

B. Samples for Verification: Submit sets of samples for each finish and color required prior to fabrication. Sample finishes shall be on the specified alloy temper, and thickness of metal required for the work; on 12-inch lengths of extrusion or 12-inch squares of sheet or plate sets; and shall show the maximum range or variation in color and shade, in not less than 4 samples per set.

1. Sample review by the Architect will be for color, texture and reflectivity.

1.6 INFORMATION SUBMITTALS

A. Certifications:

1. Prior to aluminum-framed entrance assemblies fabrication, submit certification that the aluminum-framed entrance assemblies, as designed, will meet or exceed all the specified performance requirements under full design loading. Certification shall be accompanied with engineering calculations substantiating metal framed window wall assemblies design.

2. After the installation of the aluminum-framed entrance assemblies, submit certification that these assemblies, as installed, will meet or exceed all the specified performance requirements under full design loading.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Award the fabrication of all aluminum-framed entrance components to a single firm specializing in the fabrication of aluminum-framed entrance components who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in construction with a record of successful in-service performance for a period of 5 years.

B. Curtain Wall Installer Qualifications: Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

C. Welding Qualifications: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with AWS D1.1 for steel and D1.2 for aluminum.

D. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Accessible Entrances: Comply with the following accessibility standards:

1. U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.8 IDENTIFICATION, DELIVERY, STORAGE AND HANDLING

A. Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating aluminum-framed systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 WARRANTY

A. Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS FOR EXTERIOR ALUMINUM FRAMED ENTRANCES

A. Air and vapor barrier continuity from this system to adjacent construction shall be maintained.

B. Products shall meet wind load and have or Florida Product Approvals.

2.2 ENTRANCE DOOR SYSTEMS - EXTERIOR

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

B. Manufacturers and products: provide one of the following or equal:

1. Kawneer;
2. Oldcastle Building Products
3. (Basis of Design) YKK; Series 35D Medium Stile Aluminum Outswing Entrance Door.
   a. FL 8712

C. Components and Assembly:

1. Door Design: Medium stile
   a. Bottom Rail: 9”
   b. Top Rail: 4"
   c. Verticals: 4-3/4"
2. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.

2.3 FRAMING MATERIALS AND ACCESSORIES

A. Aluminum:

1. ASTM B221, alloy 6063-T6 for extrusions; ASTM B209, alloy 5005-H16 for sheets; or other alloys and temper recommended by manufacturer appropriate for specified finish.
2. Minimum thickness of [0.080] inch for main framing members.

B. Internal Reinforcing: Entrance Frames

1. ASTM A36 for carbon steel; or ASTM B308 for structural aluminum.
2. (1 ¼" x 4 9/16" x ¼") steel channel (vertical mullions) and (1 ¼" x 4 11/16" x 12 ga) steel channel (vertical jambs) as required based on applied wind loads.
3. Steel components factory coated with alkyd type zinc chromate primer complying with FS TT-P-645.

C. Anchorage Devices:

1. Manufacturer's standard formed or fabricated steel or aluminum assemblies of shapes, plates, bars or tubes.
2. Hot-dip galvanize steel assemblies after fabrication; comply with ASTM A123, 2.0 ounce minimum coating.

D. Fasteners:

1. Aluminum, non-magnetic stainless steel or other non-corrosive materials compatible with items being fastened.
2. Provide concealed fasteners wherever possible.
3. For exposed locations, provide Phillips flathead screws with finish matching item fastened.
4. For concealed locations, provide manufacturer's standard fasteners.

E. Expansion Anchor Devices: Toothed-steel or drilled-in, expansion bolt anchors.

F. Protective Coatings: Cold-applied asphalt mastic complying with SSPC-Paint 12, compounded for 30 mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645.

G. Touch-Up Primer for Galvanized Components: Zinc oxide conforming with FS TT-P-641.

H. Glazing Gaskets:

1. Compression type design, replaceable extruded, of neoprene, polyvinyl chloride (PVC), or ethylene propylene diene monomer (EPDM) at exterior gasket. Profile and hardness as required to maintain uniform pressure for watertight seal.
2. Dow Corning #995 structural silicone sealant at glazing bead with FG5188 E.P.D.M. spacer gasket or equal.

I. Weatherstripping:

1. Provide WP-085 wool pile weatheringl in AS-6 adjustable astragal or equal.
2. Provide D-120 vinyl weatherstripping in bottom door rail or equal.

2.4 METALS

A. Aluminum: Refer to Division 08 Section "Glazed Curtain Walls."

1. Extruded Bars, Rods, Shapes and Tubes: Provide concealed extruded bars, rods, shapes and tubes in alloys as recommended by the fabricator to join or reinforce assembly of exposed aluminum components.
2. Welding Rods and Bare Electrodes: AWS A5.10.
3. Shapes and Thickness: Provide shapes as shown and as required to suit the performance requirements but with wall thickness not less than 0.188-inches.

B. Carbon Steel: For carbon steel components required to join, reinforce or support the assembly of aluminum components provide carbon steel conforming to the following standards:

1. Structural Steel Shapes, Plates and Bars: ASTM A36/A36M.

2.5 FASTENERS

A. Material: Stainless steel.

B. Fastener Metal Alloy Types, Designations, and Standards: Alloys as selected by fabricator to provide corrosion resistance with the components fastened. Do not use self-drilling, self-tapping type fasteners.

2.6 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: As specified in Division 08 Section "Glazing."

2.7 SEALING MATERIALS

A. Concealed Sealing Systems: All sealing materials concealed within the aluminum-framed architectural entrances shall be silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.

B. Exposed Sealing Systems: All sealing materials exposed at aluminum-framed entrance perimeter joints in contact with brick masonry and window walls shall be silicone as specified in Division 7 Section "Joint Sealants."

2.8 OTHER ALUMINUM-FRAMED ENTRANCES COMPONENTS

A. Door Hardware: As specified in Division 08 Sections "Door Hardware" and "Automatic Door Hardware."

B. Flashings: Flashings: Stainless steel as specified in Division 07 Section "Sheet Metal Flashing and Trim."

C. Slip and Separator Gaskets:

1. Bolted slip-joints: Non-metallic, low friction material bearing temperature and moisture resistances and low abrasion properties as required to suit performance criteria.
2. Non-bolted slip-joints: Non-corrosive, non-toxic impregnated felt, or butyl, tape with a pressure sensitive adhesive on one surface which is formulated for proper adhesion to metals shown; gasket shall bear temperature and moisture resistance properties as required to suit performance criteria; thickness and width as required.

D. Baffle Material: PVC-coated SIF-G Industrial Foam; Stephenson & Lawyer, Inc. Baffle material shall be provided with a pore count (ppi) as required by assembly fabricator.

E. Weatherstripping: Compressible weatherstripping gaskets fabricated from extruded multi-fingered PVC, silicone or neoprene, replaceable, held in adjustable depth extruded metal strips to be mortised into edge of door panels for minimum exposure, metal finish to match finish of door.

2.9 FABRICATION

A. General: Comply with the requirements of Division 08 Section "Glazed Aluminum Curtain Walls." Prefabricate the entrances to the designs and sizes shown using the materials specified and shown to produce assemblies which meet or exceed the performance requirements. To the greatest extent possible complete fabrication, assembly, finishing, hardware applications and other work before shipment to Project site.

B. Form or extrude aluminum shapes before finishing.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior for vision glass and exterior for glazing or metal panels.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At exterior doors, provide compression weather stripping at fixed stops.

G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Aluminum: Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

2.11 COATINGS FOR CONCEALED METAL SURFACES

A. General: The following protective coatings shall be applied to surfaces of metals which are to be concealed in the construction:

1. Coating for Carbon Steel: Hot dip galvanized, complying with ASTM A123.
2. Coating for Aluminum and Carbon Steel: Where aluminum or carbon steel surfaces are to be in contact with each other or in contact with dissimilar materials such as masonry or concrete, and where hot dip galvanizing of carbon steel is incompatible with component parts because of galvanic action or component fabrication tolerances provide one of the following:

   a. Bituminous Paint: MIL-C-18480, solvent coal tar base bituminous coating compound; cold applied type, non-sagging, resistant to severe corrosion conditions. Apply in two coats for an overall minimum dry film thickness of 25 mils.
   b. Zinc Chromate Primer: FS TT-P-645.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 08 Section "Glazed Aluminum Curtain Walls."

END OF SECTION 084113

SECTION 084126 -- ALL-GLASS PARTITIONS AND ENTRANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes all glass partitions and entrances as follows:

1. Interior manual-swinging all-glass entrance doors.
2. All-glass sidelights and transoms.
3. Interior all-glass butt glazed partitions.
4. Glass and glazing for all-glass systems.
5. Sealing systems.

B. Related Sections:

1. Division 05 Section "Metal Fabrications" for carbon steel framing requirements.
2. Division 08 "Door Hardware" for door hardware installed with all-glass systems.
3. Division 08 "Glazing" for laminated glass and glazing requirements.

1.3 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following. Where standards conflict the more stringent shall apply.

1. Aluminum Association (AA):

   a. No. 1 "Aluminum Standards and Data".
   b. "The Aluminum Design Manual".

2. American Architectural Manufacturers Association (AAMA):

   a. Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
   b. AAMA "Aluminum Store Front and Entrance Design Guide Manual."

3. American Institute of Steel Construction (AISC):

   a. "Steel Construction Manual," Current Edition.
   b. "Code of Standard Practice for Steel Buildings and Bridges," Current Edition.

4. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM "Metal Finishes Manual for Architectural and Metal Products."

5. Federal Standard 16 CFR 1201, Consumer Product Safety Commission (CPSC): "Safety Standard for Architectural Glazing Materials," as published in the Code of Federal Regulations (CFR). Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction,

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Structural Performance: All-glass systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7

a. Deflection Limits: Deflection normal to glazing plane is limited to 1/175 of clear span or 3/4 inch, whichever is smaller.

1.5 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated. Provide manufacturer's, finisher's, and fabricator's specifications, instructions, and installation instructions for each item or component part, and for the completely fabricated all-glass systems.

B. Shop Drawings: Show fabrication and installation details, including the following:

1. Plans, elevations, and sections.
2. Details of fittings and glazing, including isometric drawings rail fittings.
3. Door hardware locations, mounting heights, and installation requirements.

C. Samples for Verification:

1. Metal Samples: Submit sets of samples for each finish and color required prior to fabrication. Sample finishes shall be on the specified alloy temper, and thickness of metal required for the work; on 12 inch lengths of shapes or 12 inch squares of sheet or plate sets; and shall show the maximum range or variation in color and shade, in not less than 4 samples per set.

a. Sample review by the Architect will be for color, texture and reflectivity.

D. Fabrication Sample: Of continuous rail fitting at bottom of all-glass systems, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery.
2. Anchorage.
3. Glazing.

1.6 INFORMATION SUBMITTALS

A. Maintenance data.

B. Warranty: Sample of special warranty.

1.7 QUALITY ASSURANCE

A. Single Subcontract Responsibility: The Contractor shall subcontract the all-glass systems work to a single firm specializing in the design, engineering, and field erection of all-glass systems and who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Architect, and whose work has resulted in installations with a record of successful in-service performance for a period of not less than 10 years. The single firm shall be an authorized representative of the manufacturer for the type of all-glass systems required for this Project.

B. Engineering Responsibility: Prepare data for all-glass systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

C. Accessible All-Glass Entrance Doors: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ABAAS Architectural Barriers Act Accessibility Standard (ABAAS).

D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation. Use the same materials, finishes, details, and methods of connections proposed for the final work to simulate actual construction as accurately as possible in every way.

1. Build mockup of typical wall areas as shown on Drawings for the following:

   a. Interior all-glass entrances.
   b. Interior all-glass storefronts.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1.8 IDENTIFICATION, DELIVERY, STORAGE AND HANDLING

A. All components of the all-glass systems shall be identified after fabrication by marks clearly indicating their location on the building. Packaging of components shall be so selected to protect the components from damage during shipping and hoisting.

B. Storage on Site:

1. Store components in a location and in a manner to avoid damage to the components. Stacking shall be done in a way which will prevent bending, excessive pressure, abrasion or other permanent damage of the component and its finished surfaces.

2. Store components and materials in a clean, dry location, away from uncured concrete and masonry and other construction activities. Cover with non-staining waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

C. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of metals.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for all-glass systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating all-glass systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 WARRANTY

A. General: The Warranties submitted under this Section shall not deprive the Owner of other action, right or remedy that the Owner may have under other provisions of the Contract Documents and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. All-Glass Systems Materials Warranty: Submit a 10 year written warranty, beginning from date of Project Acceptance, executed by the Contractor and the all-glass systems subcontractor, agreeing to repair or replace any component of the all-glass systems work that develops defects in materials within the specified warranty period. Defects include structural failure, sealant failure, deterioration of metal finishes beyond normal wear, and any other evidence of failure or deterioration of the all-glass systems work to meet performance requirements.

C. All-Glass Systems Workmanship Warranty: Submit a 5 year written warranty, beginning from date of Project Acceptance, executed by the Contractor and the all-glass systems subcontractor, agreeing to repair or replace any component of the all-glass systems work that develops defects in workmanship within the specified warranty period. Defects include structural failure, sealant failure, deterioration of metal finishes beyond normal wear, and any other evidence of failure or deterioration of the all-glass systems work to meet performance requirements.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Project Acceptance, provide 12 months' full maintenance by skilled employees of all-glass system Installer. Include quarterly preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper all-glass system operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. All glass partition system shall be gasketed to resist the passage of smoke and held in place in the frame by a gasket that allows the system to deflect without the gasket failing to comply with the Florida Building Code for use as a glass atrium separation partition.

1. Partition is not considered a fire or smoke partition.

2.2 GLASS WALL OFFICE SYSTEM

A. Manufacturers and products:

1. CRL; CRL Frameless Cascade
2. DORMA Glas; Glass Door Assemblies.
3. (Basis of Design) ModernfoldStyles; Modernus Lama.

2.3 ALL-GLASS ENTRANCE DOORS

A. Fabricators/Installers: Provide and install All-Glass tempered glass doors as indicated.

B. Patch Fitting Configuration: Refer to Division 08 “Door Hardware.”

1. Manual-Swinging, All-Glass Entrance Doors,

a. Corner patch fittings top and bottom.

C. Anchors and Fastenings: Concealed.

D. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.

1. Class 1: Clear monolithic.

a. Note: Thickness: nominal 1/2- inch.
b. Locations: As indicated

2. Exposed Edges: Machine ground and flat polished.
3. Butt Edges: Flat ground.
4. Corner Edges: Lap-joint corners with exposed edges polished.

E. Aluminum Extrusions: ASTM B 221, with strength and durability characteristics of not less than Alloy 6063-T5.

F. Stainless-Steel Cladding: ASTM A 666, Type 304, #6 polished Finish.

1. Aluminum Finish Option: Anodized Aluminum or Powder Coated Finish (Coordinate with guard rail metal finish)

~~F.~~G. Hardware as specified in Division 08 "Door Hardware".

2.4 ALL-GLASS PARTITION WALLS

A. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.

1. Glazing Fabricator verify design thickness of glazing for design height, width and allowable deflection criteria.

B. Aluminum Extrusions: ASTM B 221 with strength and durability characteristics of not less than Alloy 6063-T5.

1. Stainless-Steel Cladding: ASTM A 666, Type 304, #8 polished Finish.
   a. Aluminum Finish Option: Anodized Aluminum or Powder Coated Finish (Coordinate with guard rail metal finish)

2.5 GLASS PARTITION WALLS - METAL COMPONENTS

A. Fitting Configuration:

1. Continuous rail fitting at top and bottom.

B. (Basis of Design) Product Characteristics:

1.	Wall Thickness	2 3/8”
2.	Min./Max. Panel Width	6”/4’
3.	Max Standard Height	10’
4.	Top Profile Height	3 3/8”
5.	Bottom Profile Height	1-1/2”
6.	Top/Bottom Sliding Profile Height	1-1/16”
7.	Side Sliding Profile Height	3/4”
8.	Top/Bottom Swing Profile Height	1-1/16”
9.	Side Swing Profile Height	13/16” - 1 1/16”
10.	Est. STC.	32 sgl - 46 dbl

C. Accessory Fittings: Match rail-fitting metal and finish.

D. Anchors and Fastenings: Concealed.

2.6 BUTT-GLAZING SEALANTS

A. Glazing Sealants: Manufacturer’s clear silicone structural rubber based sealants that are compatible with, and adherent to, substrates indicated. Sealant type as recommended by all-glass systems fabricator to suit system performance requirements and to satisfy specified warranties.

B. Manufacturer's polycarbonate extrusions or 3M Dual lock.

2.7 FABRICATION

A. General: Fabricate the all-glass systems to meet aesthetic and system performance requirements indicated. Fit and assemble components in the manufacturer’s shop to the fullest extent practicable and prior to application of finishes.

1. Before shipment, shop-assemble, mark, and disassemble components that cannot be permanently shop assembled.

B. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.

C. All-Glass Doors and Frames:

1. Preglaze door units in accordance with Division 08 Section "Glazing."
2. Fabricate all doors and frames to accommodate the swing direction shown.
3. Doors and frames shall be cut, reinforced, drilled and tapped in strict accordance with the printed door hardware manufacturer's templates and instructions. Provide solid stainless steel hardware reinforcements, securely fastened to doors and frames where door hardware is to be attached.

a. Hardware Mounting Heights: Refer to Division 08 "Door Hardware."

D. Joints in Metal Work: All exposed work shall be carefully fitted and matched to produce continuity of line and design, with all joints, being accurately fitted for hairline contact and rigidly secured. Where additional rigidity or strength is required to satisfy the performance requirements reinforce entrance components with aluminum or carbon steel shapes, bars, and plates.

E. Fabricate components to allow for structural movements, field adjustments, and minimum clearances and shimming. Fit and secure corners and joints rigidly with fasteners, internal reinforcement or welding. Make exposed framing, trim joints, and connections, flush and hairline. Match exposed work to produce continuity of line.

F. Prepare components to receive anchors, connection devices, and fasteners. Provide concealed connectors, attachments, and fasteners.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Furnish inserts at proper times for setting in work indicated to support all-glass systems work.

B. Coordinate all-glass systems work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.

C. A representative of the all-glass systems manufacturer shall be present during the entire erection of the all-glass systems.

D. Separate dissimilar metals from sources of corrosion or electrolytic action at points of contact with a protective coating of bituminous paint.

3.3 INSTALLATION

A. General: Install all all-glass systems components in strict accordance with the all-glass systems manufacturer’s instructions and approved shop drawings to the slopes, lines and levels shown. Comply with all-glass systems manufacturer's instructions for protecting, handling and installing all-glass systems components. Pay particular attention to protection of finishes and use of sealants. Discard members damaged before installation and remove installed members that become damaged; provide new acceptable components.

1. Carbon Steel Framing Members: Refer to Division 05 Section "Metal Fabrications " for requirements applicable to the erection of the carbon steel framing components of the all-glass systems. Where requirements conflict, the more stringent shall apply.

B. Anchor framing assemblies components securely and permanently in place, shimming and using attachment methods that permit adjustment for construction tolerances, irregularities, and alignment. Allow for structural movement and changes due to structural live loads.

C. Set units level, plumb, and true to line, with uniform joints.

D. Maintain uniform clearances between adjacent components.

E. Lubricate hardware and other moving parts according to manufacturer's written instructions.

F. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

G. Install butt-joint sealants according to manufacturer's instructions and as specified in Division 07 "Joint Sealants".

3.4 ERECTION TOLERANCES

A. Install all-glass systems components in place, plumb, level, accurately aligned, and without warpage or racking. Adjust all-glass systems to conform to the following tolerances:

1. Variation from theoretical calculated position as located in plan or elevation in relation to established floors lines, column lines and other fixed elements of the structure, including variations from plumb, level, straight and member size: Plus or minus 1/8 inch maximum in 10 feet, 1/4 inch in 40 feet.
2. Offsets in true alignment between adjacent members abutting or end to end in line: Plus or minus 1/32 inch maximum.

3.5 ANCHORAGE

A. Anchorage of the all-glass systems to the building structure shall be in accordance with the accepted shop drawings.

3.6 WELDING

A. Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with AWS D1.1 for concealed steel members and AWS D1.2 for exposed aluminum members. Use only methods which will avoid distortion of exposed faces.

B. Welds and adjacent concealed metal areas shall be thoroughly cleaned and coated with a single coat of bituminous paint.

3.7 GLAZING

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: As specified in Division 08 Section "Glazing."

3.8 REMOVAL OF DEBRIS

A. All debris caused by, or incidental to, the erection of the all-glass systems shall be removed from the site and disposed of legally.

3.9 ADJUSTING AND CLEANING

A. Adjust doors and hardware to produce smooth operation and tight fit at contact points. Lubricate hardware and other moving parts according to manufacturer's written instructions.

B. Clean the completed all-glass systems, both metal and glazing material, on the top and bottom exposed surfaces, promptly after erection, allowing for nominal curing of liquid sealants.

C. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

D. Replace glass during the construction period which is broken, cracked, chipped or damaged in any way and from any source, including weather, vandalism or accidents.

3.10 PROTECTION

A. Follow recommendations of the all-glass systems manufacturer for proper and adequate protection and cleaning procedures during the remainder of the construction period, so that the all-glass systems will be without damage at the time of Substantial Completion.

END OF SECTION 084126

SECTION 084423 – STRUCTURAL SEALANT GLAZED CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes but is not limited to:

1. Glazed aluminum framing system, thermally improved type, including interior and exterior exposed aluminum members, stainless steel attachment devices, flashing, expansion devices and fasteners.
2. Four Sided Structurally Glazed Curtain Walls.
~~2.~~**3. Shallow system used at Clerestory**
~~3.~~**4.** Aluminum curtain wall framing.
~~4.~~**5.** Architectural entrance doors and frames, including hardware, stripping and thresholds.
~~5.~~**6.** Aluminum copings, louvers, and condensate gutters.
~~6.~~**7.** All sills, trim, protective bars at hazardous glazing locations, and similar items in conjunction with curtain wall openings.
~~7.~~**8.** Painting and coating in conjunction with the above items.
~~8.~~**9.** Internal steel and aluminum reinforcements.
~~9.~~**10.** Internal sealing, joint fillers, weeps, vents and gasketing systems.
~~10.~~**11.** Anchors, shims, fasteners, inserts, expansion devices, accessories, support brackets and attachments.
~~11.~~**12.** Construction of performance mock-up(s) of size as may be approved by the Architect, including all coordination of chamber construction.
~~12.~~**13.** Construction of Visual Mockups
~~13.~~**14.** Coordination of testing of mockup(s) with independent testing laboratory engaged by the Owner, including all coordination of testing and testing procedures.
~~14.~~**15.** On-site testing for water leakage.
~~15.~~**16.** Glazing is physically and thermally isolated from framing members.
~~16.~~**17.** Work specified in other sections controlled by this Section include but is not limited to:
   a. Glass and glazing in conjunction with the work of this Section specified in Division 08 Section "Glazing".

~~17.~~**18.** Division 07 Sections "Thermal Insulation" and "Fire Resistive Joint Assemblies", for fire safing insulation, including supporting clips, between curtain wall and edges of floor slab construction to maintain and continue the fire resistance rating of floor slabs.
~~18.~~**19.** Sealants, joint fillers and gaskets in conjunction with curtain wall system specified in Division 07 Section "Joint Sealants".

B. Related Sections include the following:

1. Division 07 Section "Joint Sealants" for installation of joint sealants installed with structural silicone glazed curtain walls and for sealants to the extent not specified in this Section.

2. Division 07 Section "Sheet Metal Flashing and Trim" for field-formed flashings and other sheet metal work not part of glazed aluminum curtain wall assemblies.
3. Division 07 Section "Fire Resistive Joint Systems" for fire safing insulation, including supporting clips, between curtain wall and edges of floor slab construction to maintain and continue the fire resistance rating of floor slabs.
4. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
5. Division 08 Section "Glazing".
6. Division 08 Section "Glazing" for glass and glazing in conjunction with the work of this Section
7. Division 08, Section “Exterior Enclosure System Requirements” performance requirements, construction of performance mock-up(s), construction of Visual Mockups, coordination of testing of mockup(s) with independent testing laboratory engaged by the Owner, including all coordination of testing and testing procedures, and on-site testing for water leakage.
8. Division 08 Section "Louvers and Vents" for units installed with glazed aluminum curtain

1.3 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the most current edition of the following. Where standards conflict the more stringent shall apply.

1. Aluminum Association (AA):
   a. No. 1 "Aluminum Standards and Data".
   b. No. 30 "Specifications for Aluminum Structures".
   c. No. 33 "Engineering Data for Aluminum Structures".
   d. "The Aluminum Design Manual".
2. American Architectural Manufacturers Association (AAMA):
   a. AAMA "Metal Curtain Wall Manual."
   b. AAMA 501-15, "Methods of Tests for Exterior Walls"
   c. AAMA 501.1, "Standard Test Method For Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure"
   d. AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems" AAMA 503 "Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems"
   e. AAMA "Aluminum Curtain Wall Design Guide Manual," Volumes 1-9.
   f. AAMA 501.4 "Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts"
   g. AAMA 501.5 "Test Method for Thermal Cycling of Exterior Walls"
   h. AAMA 507 "Standard Practice for Determining the Thermal Performance Characteristics of Fenestration Systems Installed in Commercial Buildings"
   i. AAMA 1503 "Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections"
   j. AAMA "Curtain Wall Manual #10."
   k. AAMA "Aluminum Store Front and Entrance Design Guide Manual."
   l. AAMA 2603 "Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum."
   m. AAMA 2605 "Specification for Superior Performing Organic Coatings on Architectural Extrusions and Panels."
3. American Institute of Steel Construction (AISC), "Steel Construction Manual," Current Edition.
4. American Society for Testing and Materials (ASTM):

a. ASTM E283, "Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors."
b. ASTM E330, "Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference".
c. ASTM E331, "Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference".
d. ASTM E1332, "Classification for Determination of Outdoor-Indoor Transmission Class."

5. American Welding Society (AWS):
   a. AWS A5.10 "Specification for Aluminum and Aluminum Alloy Bare Welding Rods and Electrodes."
   b. AWS D1.1 "Structural Welding Code, Steel."
   c. AWS D1.2 "Structural Welding Code, Aluminum."
6. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM "Metal Finishes Manual for Architectural and Metal Products."
7. National Fenestration Rating Council Incorporated NFRC 500-2010; Sections 1.5, K, 3.
8. Steel Structures Painting Council (SSPC): "Steel Structures Painting Manual, Vol. 2, Systems and Specifications".
9. Federal Standard 16 CFR 1201, Consumer Product Safety Commission (CPSC): "Safety Standard for Architectural Glazing Materials," as published in the Code of Federal Regulations (CFR). Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction, wherever requirements conflict the more stringent shall be required. Obtain approvals from all such authorities. As a minimum provide safety glazing complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

1.4 SYSTEM DESCRIPTION

A. General: Curtain walls systems for this project include the following types of systems. Provide horizontally and vertically pressure equalized design.

B. System Type: Provide Four-Sided SSG - Intermediate vertical mullions and horizontal members shall be structural silicone glazed with no exposed exterior aluminum. Provide glazed aluminum curtain wall systems glazed from the outside with insulating glass units, with matching glazed insulated spandrel panels glazed from the outside for indicated locations. Provide pressure equalized design. Provide continuous thermal break construction with extruded polyamide iso-bar type.

   1. Accommodate all thermal movement and interstory differential movement that provides two lines of continuous weatherstripping and gasketed interlocking verticals at vertical unit joints.
   2. Any accommodation of movement in glass pockets or within sealant joints is not permitted.
   3. Provide aluminum extrusions at all interface conditions with adjacent construction that allow for continuous installation of joint sealants and flashing, and ensures air and moisture barrier continuity in the completed assembly.

C. System design concept shall meet all design requirements, match the sight lines as shown on the Drawings, and meet all performance requirements.

D. Extrusions: Provide curtain wall extrusions of one piece for entire depth of section on either side of the glass plane. Ganging or snapping together separate extrusions to provide indicated section depths is not permitted.

E. Reglazing: Design, fabricate, and install curtain wall glazing to allow reglazing of vision glass from the exterior of the building, and reglazing of spandrel glass from the exterior of the building, without modification or alteration of the original curtain wall components, using original materials without the use of supplemental or replacement parts.

F. Glazing Gaskets: Design glazing gaskets in accordance with the following requirements:

1. Provide interior and exterior gaskets (exterior glazed)..
2. Provide glazing gaskets with factory molded corners at both interior and exterior.
3. Glazing gaskets shall accommodate all variation in infill and all extrusion tolerances for glazing pockets without causing leakage or excessive pressure on glass or other infill materials. Gasket thickness in the installed/compressed position shall be a minimum of 0.25-inch thick.

G. Weeps to Exterior: Weep all gutters, glazing pockets, and similar items, to the exterior, providing weep holes large enough to provide pressure equalization of pocket/gutter areas.

1. Baffle all weeps at exterior of wall assemblies using open cell sponge.

H. Slab Anchorage: Design curtain wall slab anchorage system to accommodate not less than plus or minus 1-inch variation in surrounding and supporting work.

1.5 PERFORMANCE REQUIREMENTS

A. General: Provide glazed curtain wall systems, and glazing assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:

1. Structural loads listed on structural drawings.
2. Thermal movements.
3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, shrinkage, deflection from uniformly distributed and concentrated live loads, and similar movements.
4. Dimensional tolerances of building frame and other adjacent construction.
5. Failure includes the following:

a. Deflection exceeding specified limits.
b. Thermal stresses transferred to building structure.
c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
d. Glazing-to-glazing contact.
e. Noise or vibration created by wind and thermal and structural movements.
f. Loosening or weakening of fasteners, attachments, and other components.
g. Sealant failure.
h. Air leakage exceeding specified limits.
i. Water penetration exceeding specified limits.

B. Structural Loads: Provide glazed aluminum curtain wall systems, including anchorage, capable of withstanding, without failure, the effects of the following design loads within limits and under conditions indicated:

1. Wind Loads: The glazed aluminum curtain wall systems shall be designed, fabricated, and installed to withstand the maximum inward and outward wind pressures required by the Florida Building Code, and as shown on the Drawings.
a. Ultimate Design Wind Speed: As indicated on drawings.

b. Risk Category: As indicated on drawings.
c. Exposure Category: As indicated on drawings.

2. Exterior Maintenance Loads: The glazed aluminum curtain wall systems shall be designed, fabricated, and installed to withstand the loads caused by exterior maintenance equipment.

C. Structural-Test Performance: Provide glazed aluminum curtain wall systems tested according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, component breakage or disengagement, and permanent deformation of main framing members exceeding 0.1 percent of span.
3. Test Duration: As required by design wind velocity but not less than 60 seconds.

D. Deflection:

1. General: Base calculations for the following deflections upon the combination of maximum direct wind loadings, building deflections, thermal stresses, and erection tolerances.

2. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.

3. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 25 percent of design dimension or 1/8-inch, whichever is greater.

a. Single lite edge of glass deflection shall be limited to 3/4” along any length of supported glass edge.
b. Door Openings: Limit deflections of aluminum members spanning door openings to 1/360 of clear span. Provide a minimum 1/16-inch clearance between framing members and an operable door.

4. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.

5. Glass, sealants and interior finishes shall not be included to contribute to framing member strength, stiffness or lateral stability.

6. Do not permit any permanent deformation (set) in the aluminum framing work. Permanent deformation shall be taken as deflection without recovery exceeding 0.1 percent of span.

7. Twisting (rotation) of the horizontals due to the weight of glass shall not exceed 1 degree, measured between ends and center of each span.

E. Structural-Sealant Glazing for Glazing Assemblies:

1. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by glazing system assemblies without failing adhesively or cohesively. Sealant fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.

a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi.

a. Structural-sealant joints do not carry gravity loads of glazing.

F. Story Drift: Provide glazed aluminum curtain wall systems that accommodates 2x design displacement of adjacent stories indicated.

1. Design Displacement: Design displacement is available from the structural engineer and including the following:

a. L/400 or 1/2" max for wind

G. Thermal Movements: Provide glazed aluminum curtain wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures, without causing buckling, stress on glass, breakage of glass, glazing-edge seal failure, sealant failure, or excess stress on curtain-wall framing, anchors and fasteners. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

H. Provision for Building Movements: Design, fabricate and install glazed aluminum curtain wall systems to withstand building movements including thermal movements, loading deflections, shrinkage, creep and similar movements. Thermal movements shall be as specified above. Building frame deflections, shrinkage, creep and other movements are available from the structural engineer.

I. Air Infiltration: Provide glazed aluminum curtain wall systems with maximum air leakage of 0.06-cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure differential of 6.24-lbf/sq. ft.

J. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

K. Water Penetration under Static and Dynamic Pressure: Provide aluminum glazed curtain wall systems that do not evidence water penetration when tested according to ASTM E 331 for one 15 minute cycle at a minimum differential static pressure of 15-lbf/sq. ft. and AAMA 501 at a dynamic pressure of 15 PSF.

1. Maximum Water Leakage: No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

2. Provision shall be made to drain to the exterior face of the wall any water entering the glazed aluminum curtain wall system.

L. Thermal Movement: Provide for thermal movement caused by 180 degrees F surface temperature, without causing buckling stresses on glass, joint seal failure, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or detrimental effects.

M. Thermal Performance:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than as follows, including center-of-glass, frame, and edge effects, as determined according to NFRC 102.
   a. Shop Glazed: 0.36 BTU/HR/FT²/ºF or less.
   b. Field Glazed: 0.38 BTU/HR/FT²/ºF or less.

2. Condensation Resistance: Provide glazed aluminum curtain wall systems with condensation-resistance factor (CRF) when tested according to AAMA 1503 of not less than:
   a. Shop Glazed: A minimum of 80.
   b. Field Glazed: A minimum of 76.

3. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.3.

N. Design Modifications:

1. Submit design modifications necessary to meet the performance requirements and field coordination.
2. Variations in details or materials shall not adversely affect the appearance, durability or strength of components.
3. Maintain the general design concept without altering size of members, profiles and alignment.

O. Acoustical Performance: When tested in accordance with ASTME 90 and AAMA 1801:
1. Sound Transmission Class (STC) shall not be less than:
   a. 1” IGU; 33, 1” Laminated; 37 (Shop Glazed)
   b. 1” IGU; 33, 1” Laminated; 36 (Field Glazed)
2. Outdoor–Indoor Transmission Class (OITC) shall not be less than:
   a. 1” IGU; 26, 1” Laminated; 31 (Shop Glazed)
   b. 1” IGU; 27, 1” Laminated; 31 (Field Glazed)

P. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.

2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

1.6 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated. Provide Manufacturer's, finisher's, and fabricator's specifications, instructions, and installation instructions for each item or component part, and for the completely fabricated structural sealant glazed curtain wall assemblies.

B. Shop drawings: Provide shop drawings showing materials in place on the building including coordination of related and adjoining work, insert drawings and erection diagrams. Show relative layout for all adjacent walls, beams, columns, slabs, ceilings, etc. Drawings shall include elevations, floor plans, sections, and full size details. Details shall be full size and fully drawn, not outlined. Provide isometric details of any conditions, as requested by the Design Professional. Drawings shall include the following information:

1. Show curtainwall elements in elevation, section, and details.

2. Shop drawings shall include:

   a. Glass and metal thicknesses including tolerances.
   b. Joining details and internal weather seals.
   c. Field connections, weld sizes, anchorages, and fasteners, embedment length, and edge distances.
   d. Sealants identification by product name and manufacturer, including cleaning and priming requirements.
   e. Relative layout of walls, beams, columns, and slabs with dimensions noted. Dimension all tolerances required or which can be accommodated.
   f. Provisions for expansion.
   g. Fastening and sealing methods.
   h. Splice details.
   i. Metal finishes.
   j. Hardware for entrances and glazing accessories insulation.
   k. Reglazing and glazing procedures.
   l. Dimension limits of movements for all moving joints and provisions for expansion and contraction.
   m. Spotting plans for preset inserts in structure or in adjacent construction.
   n. Perimeter sealant joint sizes, including tolerances and minimum/maximum joint sizes required.

3. Indicate relationships with adjacent and interfacing work. Include mock up if a stand- alone element.

C. Engineered Shop Drawings: Provide structural calculations, structural design calculations bearing seal of professional engineer licensed in State of Florida prepared in compliance with referenced documents and these specifications. Where specifications and code differ, the more severe requirements shall govern.

1. Test reports are not an acceptable substitute for calculations. Calculations shall include the following information:
2. Analysis for all applicable loads on framing members.

3. Analysis for all applicable loads on anchors, including anchors embedded in concrete.
4. Section property computations for framing members.

D. Samples for Verification: Submit sets of samples for each finish and color required prior to fabrication. Sample finishes shall be on the specified alloy temper, and thickness of metal required for the work; on 12-inch lengths of extrusion or 12-inch squares of sheet or plate sets; and shall show the maximum range or variation in color and shade, in not less than 4 samples per set.

1. Sample review by the Design Professional will be for color, texture and reflectivity.

E. Construction Samples: 24-inches wide by 48-inches high section representing the construction of curtain wall framing, insulated vision units, insulated spandrel units, and horizontal louver blinds. Sample shall have one intermediate horizontal framing member creating two framing openings with insulated vision unit and horizontal louver blinds in the top opening, and insulated spandrel unit in the lower opening.

1.7 INFORMATION SUBMITTALS

A. Test Reports: Submit certified product test reports based on tests performed by an AAMA Accredited Laboratory clearly describing in written form, and in shop drawing form, compliance of each structural sealant glazed curtain wall assembly (each curtain wall and storefront) with requirements indicated based on comprehensive testing.

B. Certifications:

1. Prior to structural sealant glazed curtain wall assemblies fabrication, submit certification that the structural sealant glazed curtain wall assemblies, as designed, will meet or exceed all the specified performance requirements under full design loading. Certification shall be accompanied with engineering calculations substantiating Structural Sealant Glazed Curtain Wall assemblies design.
2. After the installation of the Structural Sealant Glazed Curtain Walls, submit certification that these assemblies, as installed, will meet or exceed all the specified performance requirements under full design loading.

C. Preconstruction Sealant Compatibility and Adhesion Testing: Test results confirming compatibility and adhesion are mandatory for all concealed and exposed sealant materials in contact with exterior glazing, metal panels, other sealants, flashings, metal framing, and shims prior to full size sample installation construction. Refer to Division 07 Section “Joint Sealants” for specific testing requirements, and anticipated lead time necessary to perform testing.

D. Welding certificates: with current expiration date; maintain active certificates throughout entire project.

E. Qualification Data: For Installer.

F. Maintenance Instructions: Submit maintenance instructions for each type of product specified.

G. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

A. Single Subcontract Responsibility: Contractor shall subcontract the window, curtain wall, and storefront systems work to a single firm specializing in the design, engineering, fabrication, and field erection of custom windows, curtain walls, and storefronts who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Design Professional, and whose work has resulted in installations with a record of successful in-service performance for a period of not less than 10 years. The Curtain Wall Subcontractor shall have sufficient production capacity, have organized quality control and testing procedures, to produce and properly install the curtain wall assemblies required without causing delay in progress of the Work.

B. Installer Qualifications: Subcontract the structural sealant glazed curtain wall work to a firm which is specialized in the erection of custom curtain walls, and who has successfully produced work similar in design and extent to that required for the project, in not less than three projects of similar scope to the satisfaction of the Design Professional, and whose work has resulted in construction with a record of successful in-service performance for a period of not less than 10 years.

C. Testing Laboratories Qualifications: Testing laboratories shall be specifically qualified and AAMA accredited to conduct laboratory and field performance tests required by these specifications and acceptable to the Design Professional. Curtain Wall subcontractor’s own test facilities will not be acceptable.

D. Welding Qualifications: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with AWS D1.1 for steel and D1.2 for aluminum.

E. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Design Professional, except with Design Professional's approval. If modifications are proposed, submit comprehensive explanatory data to Design Professional for review.

F. Compatibility Testing: For structural-sealant-glazed sloped glazing systems, perform structural- and nonstructural-sealant manufacturer's standard preconstruction tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by sloped glazing systems.

1. Test a minimum of five samples of each metal, glazing, and other material.
2. Prepare samples using techniques and primers required for installed sloped glazing systems.
3. For materials that fail tests, determine corrective measures required to prepare each material to ensure compatibility with and adhesion of sealants, including, but not limited to, specially formulated primers. After performing these corrective measures on the minimum number of samples required for each material, retest materials.

G. Sample Installations and Field Testing: Construct sample installations of the final exterior wall assemblies where shown on the drawings.

1. General: Sample installations will be used as a standard for judging acceptability of work for the Project. Replace unsatisfactory work as directed. Maintain sample installations

during construction as a standard for judging acceptability of the exterior wall work. Properly finished, maintained, and performing sample installations shall be retained as a portion of the completed work.

a. Complete all field testing successfully prior to installation of interior materials or finishes on the interior side of the curtain walls.

2. Size: Provide full sized sample installations. Sample installations shall be built on site complete with all glass, aluminum framing, anchors, connections, flashings, sealants, and joint fillers as accepted on the final shop drawings. Do not take special precautions or use techniques that do not represent those to be used on the work. Do not enclose the interior side of the wall with interior finishes and insulation materials.

3. Field Testing: Owner shall engage field testing agency to perform Field Testing: test a minimum of two sample installations, at three separate locations minimum, in accordance with the specified field test method. Conduct one test at 10 percent of completion, and one test at 40 percent of completion. Conduct tests of each specified sample installation under the direction of the testing laboratory in the presence of the Design Professional, the Contractor, various component manufacturers and fabricators and the Installer for each system incorporated in the sample installation.

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a. Field Test for Water Leakage: AAMA 503.

1) Water Spray Test With Uniform Air Pressure Difference: ASTM E 1105, Procedure A. Minimum test pressure difference shall be 15 lbf/sq. ft.
2) Correct all deficiencies observed as a result of this test.

H. Preinstallation Conference: Prior to the start of the exterior wall work, and at the Contractor's direction, meet at the site and review the installation procedures and coordination with other work. Meeting shall include Design Professional, Owner’s Field Inspection and Testing Agent, Contractor, steel installer, structural sealant glazed curtain wall installer, sealant installer, as well as any other subcontractors or material technical service representatives whose work, or products, must be coordinated with the exterior wall work.

1.9 IDENTIFICATION, DELIVERY, STORAGE AND HANDLING

A. General: Comply with the applicable provisions of AAMA "Curtain Wall Manual #10" for the care and handling of architectural aluminum from shop to site.

B. All components of the structural sealant glazed curtain walls shall be identified after fabrication by marks clearly indicating their location on the building. Packaging of components shall be so selected to protect the components from damage during shipping and hoisting.

C. Storage on Site:

1. Store wall components in a location and in a manner to avoid damage to the wall components. Stacking shall be done in a way which will prevent bending, excessive pressure, abrasion or other permanent damage of the component and its finished surfaces.

2. Store aluminum components and materials in a clean, dry location, away from uncured concrete and masonry and other construction activities. Cover with non-staining waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

D. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of metals.

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain wall systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating glazed aluminum curtain-wall systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.11 WARRANTY

A. General: The Warranties submitted under this Section shall not deprive the Owner of other action, right or remedy that the Owner may have under other provisions of the Contract Documents and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. Warranty for Structural Sealant Glazed Curtain Wall Assemblies: Submit a 5 year written warranty, beginning from date of substantial completion, executed by the Contractor and the curtain wall subcontractor, agreeing to repair or replace any component of the structural sealant glazed curtain wall work that develops defects in materials or workmanship within the specified warranty period. Defects include structural failure, sealant failure, uncontrolled water leakage, uncontrolled air leakage, deterioration of metal finishes beyond normal weathering, failure of operating parts to function properly, and any other evidence of failure or deterioration of the structural sealant glazed curtain wall work to meet performance requirements.

C. Warranty, High Performance Organic Coatings: Submit a warranty for a period of twenty (20) years, warranting the integrity of film and permanence of color of the high performance organic coatings for the following:

1. Color fade not to exceed 5 delta E units (Hunter) as calculated in accordance with ASTM D2244 on exposed surfaces cleaned with clean water and a soft cloth.
2. Degree of chalking not to exceed rating No. 8 when measured in accordance with ASTM D659 on exposed unwashed surfaces.

D. Warranty, Thermosetting Acrylic Enamel Coatings: Submit a warranty for a period of five (5) years, warranting the integrity of film against cracking, chipping, flaking, peeling and blistering of the thermosetting acrylic enamel coatings.

PART 2 - PRODUCTS

2.1 GLAZED ALUMINUM CURTAIN WALLS

A. Manufacturers: Provide products by one of the following or equal.

1. (Basis of Design) YKK AP America Inc, Austell Georgia.

a. Curtain Wall System: YKK AP YCW 750 SSG Curtain Wall System.

b. Florida Product Approval #: FL15921-R1.

2. Acceptable Manufacturers and Products:

a. Kawneer;
b. Oldcastle
c. West Tampa Glass

B. Product Characteristics Typical at Curtain Walls and other areas as noted:

1. Four Side SSG - Intermediate vertical mullions and horizontal members shall be structural silicone glazed with no exposed exterior aluminum.
   a. System sightline: 2-1/2 inches.
   b. Base Depth: 10-3/8" inches.
2. Stick-built.
3. Shop glazed with SSG Front Set.
4. Glass: 1” IGU.
5. Accommodates splayed wall designs.
6. Perimeter members shall include perimeter trim with 1” face dimension.
7. Thermally broken. Tested in accordance with AAMA 1503 and under NFRC(102).
8. Water infiltration: 4-sided dynamic and static: 15 PSF.
9. Field Water testing. After initial installations, Contractor conducts chamber field water tests, using ASTM E 1105 procedures at 15 psf.

C. Aluminum Curtain Wall System at Clerestory:

1. (Basis of Design) West Tampa Glass: WTG 500

2. Product Characteristics:

a. Efficient design for lower spans or pressures.
b. ASTM E 331 Water 20+ PSF
c. Uniform 2 1/2” sight lines to match and integrate with WTG 700 and WTG 900 curtain walls.
d. Structurally Silicone Glazed and sealed
e. Air-Vapor barrier system integrates with building’s air-vapor barrier design
f. Quality controlled Factory Glazing

3. Florida Product Approvals:

a. FPA FL12809.1 WTG500LMI HVHZ
b. FPA FL12809.2 WTG500SMI HVHZ
c. FPA FL12809.3 WTG500NI HVHZ

2.2 METALS

A. Aluminum: Conform to the requirements published in AA "Aluminum Standards and Data", referenced ASTM standards, and the following. All aluminum extrusions shall be manufactured to dimensional tolerances not exceeding those published in the applicable sections of AA publication "Aluminum Standards and Data".

1. Alloys:

a. Extruded Bars, Rods, Shapes and Tubes: AA Alloy 6063 and ASTM B221 with tempering as required to suit performance requirements and finishes specified. Provide concealed extruded bars, rods, shapes and tubes in alloys as recommended by the fabricator to join or reinforce assembly of exposed aluminum components.
   1) Extrusions shall be sized for complete overhead concealment of door closers, where such are scheduled or shown. Provide access for maintenance.
b. Sheet and Plate: AA Alloy 5005 and ASTM B209 with tempering as required to suit performance requirements and finishes specified.
c. Welding Rods and Bare Electrodes: AWS A5.10.

2. Shapes and Thickness: Provide shapes as shown and as required to suit the performance requirements but with wall thickness not less than the following:

   a. Minimum Wall Thickness for Structural Extrusions: 0.125-inch.
   b. Minimum Wall Thickness for Non-Structural Extrusions: 0.063-inch.

B. Carbon Steel: For carbon steel components required to join, reinforce or support the assembly of aluminum components provide carbon steel conforming to the following standards:

   1. Structural Steel Shapes, Plates and Bars: ASTM A36/A36M.

2.3 FASTENERS

A. Material: Stainless steel.

B. Fastener Metal Alloy Types, Designations, and Standards: Type 300 series alloys as selected by fabricator to provide corrosion resistance with the components fastened.

C. Self-Locking Devices: Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

D. Movement Joints: At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: As specified in Division 08 Section "Glazing."

2.5 SEALING MATERIALS

A. Concealed Sealing Systems: All sealing materials concealed within the curtain wall assembly shall be silicone, compatible with and adherent to each material it will be in contact with, as recommended by the manufacturer to fulfill performance requirements.

B. Exposed Sealing Systems: All sealing materials exposed within the curtain wall assemblies and at curtain wall assembly perimeter joints in contact with metal panels shall be silicone as specified in Division 07 Section "Joint Sealants".

2.6 OTHER CURTAIN WALL COMPONENTS

A. Entrance Doors and Frames: As specified in the following Sections:

1. Division 08 Section ""Aluminum Entrance Doors."

B. Flashings: Stainless steel as specified in Division 07 Section "Sheet Metal Flashing and Trim."

C. Copings: Aluminum to match metal panels.

D. Condensate Gutters: Provide shop fabricated extruded aluminum units of the type, size, and profiles required and as shown to form a complete and continuous waterproof and weatherproof gutter system complete with prefabricated corner units, expansion joints, and anchoring devices.

E. Isolators: Where indicated provide rigid PVC isolators of profile and hardness as recommended by the curtain wall fabricator, and fabricated to a cross sectional profile to interlock with aluminum extrusions for isolation of exterior window frame snap caps and pressure bars to interior window frame.

F. Slip and Separator Gaskets:

1. Bolted slip-joints: Non-metallic, low friction material bearing temperature and moisture resistances and low abrasion properties as required to suit performance criteria.

2. Non-bolted slip-joints: Non-corrosive, non-toxic impregnated felt, or butyl, tape with a pressure sensitive adhesive on one surface which is formulated for proper adhesion to metals shown; gasket shall bear temperature and moisture resistance properties as required to suit performance criteria; thickness and width as required.

G. Baffle Material: PVC-coated SIF-G Industrial Foam; Stephenson & Lawyer, Inc. Baffle material shall be provided with a pore count (ppi) as required by assembly fabricator.

H. Insulating Materials: As specified in Division 07 Section "Thermal Insulation."

I. Fire Safing Insulation: As specified in Division 07 Section "Fire-Resistive Joint Systems."

J. Louvers: As specified in Division 08 Section "Louvers and Vents."

K. Thermal Break Material: Provide a thermally broken design for the curtain walls as accepted by the Owner.

1. Extruded Polyamide Thermal Isolator: Extruded polymide thermal isolator shall be glass fiber reinforced extruded polymide nylon. The extruded polymide thermal isolator shall be tested by an independent testing laboratory for tensile strength, melting point, density, hardness, elongation, and co-efficient of thermal expansion, to comply with requirements as recommended by manufacturer.

2.7 FABRICATION

A. General: Fabricate the curtain wall assemblies to the designs and sizes shown using the materials specified and shown to produce assemblies which meet or exceed the performance requirements. To the greatest extent possible complete fabrication, assembly, finishing, hardware applications and other work before shipment to Project site.

B. Joints in Metal Work: All exposed work shall be carefully fitted and matched to produce continuity of line and design, with all joints, being accurately fitted for hairline contact and rigidly secured. Where additional rigidity or strength is required to satisfy the performance requirements reinforce curtain wall components with aluminum or carbon steel shapes, bars, and plates.

C. Shop Assembly: As far as practical, all fitting and assembly work shall be done in a curtain wall fabrication shop.

1. Framing members attaching curtain wall components to building supports shall provide for 3-way adjustment to accommodate fabrication and construction tolerances, and allow for thermal and building movements.
2. Provide weepholes and internal water passages in the glazing framing recesses as recommended by the respective glass and framing manufacturers to conduct infiltrating water to the exterior. Provide weep baffles secured to inside of frame behind weepholes.
3. Endcaps for extrusions shall be flush.

D. Exposed Fasteners: Not permitted, unless otherwise indicated on Drawings.

E. Protection of Metals: Wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc, or relatively small areas of stainless steel, separate such surfaces with a coating of zinc chromate primer, bituminous paint, or separation gaskets as the condition requires. Wherever aluminum comes in contact with concrete surfaces separate such surfaces with a coating of zinc chromate primer, bituminous paint, or separation gaskets as the condition requires.

F. Welding: Complete the welding of exposed surfaces prior to finishing.

1. All welding shall be in accordance with the recommendations of the AWS and shall be performed with electrodes and/or by methods recommended by suppliers of the metal being welded.
2. Welds behind finished surfaces shall be so performed as to minimize distortion on the finished side. Weld spatter and welding oxides on finished surfaces shall be removed immediately.
3. At joints where welding cannot be performed use concealed stainless steel fasteners to join assembly.

G. Shop Painting of Carbon Steel: Ungalvanized steel items shall be thoroughly cleaned of all loose scale, filings, dirt, and other foreign matter, in accordance with SSPC SP3 "Power Tool Clean", and painted with coating as specified for carbon steel surfaces.

2.8 ALUMINUM FINISHES

A. General:

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Finishes Application: Apply high performance organic coatings to all exposed exterior surfaces of curtain wall components. Apply thermosetting acrylic enamel coatings to all exposed interior surfaces of curtain wall components.

a. During production, maintain large size color range samples for use in comparing against production material.

b. Adhesion and Compatibility Testing: Test samples of aluminum coatings on aluminum will be required for compatibility and adhesion testing of all joint sealants proposed for use on curtain wall framing components prior to curtain wall sample installations. Refer to Division 7 Section Joint Sealants.

B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and with manufacturer's standart percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. (Basis of Design) Valspar or approved equal.

2. Color and Gloss: to match the composite metal panels.

2.9 COATINGS FOR CONCEALED METAL SURFACES

A. General: The following protective coatings shall be applied to surfaces of metals which are to be concealed in the construction:

1. Coating for Carbon Steel: Hot dip galvanized, complying with ASTM A123.
2. Coating for Aluminum and Carbon Steel: Where aluminum or carbon steel surfaces are to be in contact with each other or in contact with dissimilar materials such as masonry or concrete, and where hot dip galvanizing of carbon steel is incompatible with component parts because of galvanic action or component fabrication tolerances provide one of the following:

   a. Bituminous Paint: MIL-C-18480, solvented coal tar base bituminous coating compound; cold applied type, non-sagging, resistant to severe corrosion conditions. Apply in two coats for an overall minimum dry film thickness of 25 mils.
   b. Zinc Chromate Primer: FS TT-P-645.

3. Sound Deadening: Products that may be incorporated into the Work include, but are not limited to the following:

   a. Korfund Vibradamper Compound Type 80A; Dorfund Dynamics Corp.
   b. ZPG-1021 Undercoating Sealant; Ziebart Products Group, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

A. Furnish inserts at proper times for setting in work indicated to support curtain wall work.

B. Coordinate curtain wall work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.

3.2 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Before beginning installation of the curtain wall work examine all parts of the building structural frame indicated to support the curtain wall work. Notify Contractor in writing, of any dimensions, or conditions, found which will prevent the proper execution of the curtain wall work, including specified tolerances. Use Contractor's offset lines and bench marks as basis of measurements.
3. Visually inspect anchorage of existing cladding intended to support new fenestration to ensure suitability for design loading and inter-story movement, and representative existing and proposed anchors and precast concrete panels should be tested to confirm capacity to accommodate imposed loads and design criteria.

3.3 INSTALLATION

A. General: Erect all components of the curtain wall in accordance with the manufacturer's written instructions and recommendations.

1. Cut and trim component parts of the curtain wall during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely to protect material and remove all evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance, as directed.
2. Set components within the erection tolerances with uniform joints where shown. Place components on aluminum or stainless steel shims and fasten to supporting substrates using bolts and similar fasteners.
3. Do not erect components which are warped, deformed, bowed, defaced or otherwise damaged as to impair strength. Remove and replace members damaged in the process of erection.
4. Coat concealed surfaces of dissimilar materials, and any ferrous metal components, with a heavy coating of bituminous paint, zinc chromate primer or other separation in accordance with manufacturer's recommendations.
5. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

B. Curtain Wall Framing: Erect plumb and true, in proper alignment and relation to established lines and grades and within the specified erection tolerances.

C. Entrance Doors: Doors shall be securely anchored in place to a straight, plumb, and level condition, without distortion. Weatherstipping contact and hardware movement shall be field tested and final adjustment made for proper operation and performance of doors.

1. Set threshold members in a bed of sealant or with joint fillers or gaskets as indicated to provide weathertight construction. Comply with requirements of Division 7 Section "Joint Sealants" for sealants, fillers, and gaskets to be installed during installation of doors and frames.

D. Metal Wall Panels: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Orientation of the grain for all metal panels shall be the same throughout the project.

E. Install glazing as specified in Division 08 Section "Glazing."

1. Structural-Sealant Glazing:

a. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

b. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.

F. Louvers: As specified in Division 08 Section "Exterior Louvers."

3.4 ERECTION TOLERANCES

A. The structural sealant glazed curtain walls shall be designed and erected to accommodate the dimensional tolerances of the building structural frame while providing the following as installed tolerances.

1. Variation from theoretical calculated position as located in plan or elevation in relation to established floors lines, column lines and other fixed elements of the structure, including variations from plumb, level, straight and member size: Plus or minus 1/4-inch maximum in any 20-foot, column-to-column bay, or floor-to-floor height.
2. Offsets in true alignment between adjacent members abutting or end to end in line: Plus or minus 1/16-inch maximum.
3. Variation from angle, or plumb, shown: Plus or minus 1/8-inch maximum in 10-foot run or story height, non-cumulative.
4. Variation from slope, or level, shown: Plus or minus 1/8-inch maximum in any 20-foot run or column-to-column bay, non-cumulative.

B. Install sloped glazing systems to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet but no greater than 1/4 inch over total length.

3.5 ANCHORAGE

A. Anchorage of the curtain wall to the building structure shall be in accordance with the accepted shop drawings.

3.6 WELDING

A. Weld with electrodes and by methods recommended by manufacturer of material being welded, and in accordance with AWS D1.2 for aluminum and AWS D1.1 for concealed steel members. Use only methods which will avoid distortion of exposed faces.

B. Welds and adjacent metal areas shall be thoroughly cleaned and coated with a single coat of bituminous paint.

3.7 GLAZING

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: As specified in Division 08 Section "Glazing."

3.8 SEALING COMPONENTS

A. Concealed Sealing Components: Apply sealant and gasket components which are integral to the curtain wall framing system in strict accordance with the each component manufacturers printed instructions. Before applying components remove all mortar, dust, dirt, moisture, and other foreign matter which will be deleterious to the intended performance of the component. Mask adjoining exposed surfaces to avoid spilling, dripping, dropping or other unintended contact of the sealing components onto adjacent exposed surfaces.

B. Exposed Sealing Components except Exposed Gaskets: As specified in Division 07 Section "Joint Sealants."

3.9 FIELD APPLIED INSULATION

A. Exterior Wall Building Insulation: As specified in Division 07 Section "Thermal Insulation."

B. Safing Insulation: Clean debris from behind curtain wall framing during erection and provide temporary closures to prevent further accumulation of debris. Install safing insulation to comply with local authorities having jurisdictions and AAMA TIR-A3 "Fire Resistive Design Guidelines for Curtain Wall Assemblies." Install safing insulation with securely anchored metal flanges or make equivalent provisions to prevent dislocation. Comply with the requirements of Division 07 Section "Fire-Resistive Joint Systems."

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.

1. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.

   a. Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2 shall be used.

      1) A minimum of six areas on each building face shall be tested.
      2) Repair installation areas damaged by testing.

2. Structural-Sealant Glazing Inspection: After installation of curtain wall systems are complete, structural-sealant glazing shall be inspected and evaluated according to ASTM C 1401 recommendations.

3. Water Spray Test: After the installation of minimum area of 75 feet by 2 story Curtain wall system has been completed but before installation of interior finishes has begun, a 2-bay area of system designated by Design Professional shall be tested as specified in Article "Quality Assurance" and shall not evidence water penetration.

C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REMOVAL OF DEBRIS

A. All debris caused by, or incidental to, the erection of the curtain wall assemblies shall be removed from the site and disposed of legally.

3.12 CLEANING

A. Clean the completed sloped glazing systems on top and bottom exposed surfaces promptly after erection, allowing for nominal curing of sealants.

1. Remove temporary protective coverings and strippable coatings from prefinished metal surfaces immediately after installation. Remove labels and part-numbering markings from all components.

B. Replace glass during the construction period which is broken, cracked, chipped, or damaged in any way and from any source, including weather, vandalism, or accidents.

C. Clean metal surfaces promptly after installation, exercising care to avoid damage to factory finished exposed surfaces.

D. Clean glass surfaces after installation complying with requirements contained in Division 8 Section “Glazing” for cleaning and maintenance. Remove excess glazing and sealant compounds, dirt, and other substances.

E. Immediately remove mortar, fireproofing and any other deleterious material from surfaces of aluminum.

3.13 PROTECTION

A. Institute protective measures required throughout the remainder of the construction period to ensure that sloped glazing assemblies, curtain wall work will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 084413

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Integrated Door Opening Assemblies”.
3. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
4. Division 08 Section “All-Glass Entrances”.
5. Division 08 Section “Automatic Door Operators”.
6. Division 28 Section “Access Control”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI/SDI A250.13 - Testing and Rating of Severe Windstorm Resistant Components for Swing Door Assemblies.
3. ASTM E1886 - Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure difference.
5. ASTM E1996 - Standard specification for performance of exterior windows, curtain walls, doors and storm shutters impacted by Windborne Debris in Hurricanes.
6. ICC/IBC - International Building Code.
7. NFPA 70 - National Electrical Code.
8. NFPA 80 - Fire Doors and Windows.
9. NFPA 101 - Life Safety Code.
10. NFPA 105 - Installation of Smoke Door Assemblies.
11. TAS-201-94 - Impact Test Procedures.
12. TAS-202-94 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components using Uniform Static Air Pressure.

13. TAS-203-94 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.
14. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

   a. Type, style, function, size, label, hand, and finish of each door hardware item.
   b. Manufacturer of each item.
   c. Fastenings and other pertinent information.
   d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   e. Explanation of abbreviations, symbols, and codes contained in schedule.
   f. Mounting locations for door hardware.
   g. Door and frame sizes and materials.
   h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

   a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.

b. Complete (risers, point-to-point) access control system block wiring diagrams.
c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Proof of Qualification: Provide copy of manufacturer(s) Factory Trained Installer documentation indicating proof of status as a qualified installer of Windstorm assemblies.

E. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

F. Informational Submittals:

1. Hurricane Resistant Openings (State of Florida): Within the State of Florida, provide copy of current State of Florida Product Approval or Metro-Dade County Notice of Acceptance (NOA) as proof of compliance that doors, frames and hardware for exterior opening assemblies have been tested and approved for use at the wind load and design pressure level requirements specified for the Project.

a. Hurricane Resistant Components (State of Florida): Within the State of Florida, provide copy of independent, third party certified listing to ANSI A250.13.

2. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Windstorm Assembly Installer Qualifications: Installers are to be factory trained for shop and field installation prior to project bid, and are responsible for commissioning, servicing, and warranting the installed equipment specified for the project. A pre-installation site inspection of the frame and floor conditions shall be conducted by the factory trained installer prior to any Windstorm assembly hardware applied to the opening.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Hurricane Resistant Exterior Openings (State of Florida including the High Velocity Hurricane Zone (HVHZ)): Provide exterior door hardware as complete and tested assemblies, or component assemblies, including approved doors and frames specified under Section 081113 "Hollow Metal Doors and Frames", to meet the wind loads, design pressures, debris impact resistance, and glass and glazing requirements as detailed in the current State of Florida building code sections applicable to the Project.

1. Each unit to bear third party permanent label in accordance with the Florida Building Code requirements.

G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual surface door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size and Weight: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” heavy weight.

3. Hinge Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Non-ferrous, ball bearing or oil impregnated bearing hinges.
b. Interior Doors: Steel, ball bearing or oil impregnated bearing hinges.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

a. Bommer Industries (BO).
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
c. Stanley Hardware (ST).

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Bommer Industries (BO).
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

C. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed teflon coated stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
b. Stanley Hardware (ST) – C Option.

B. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to

accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable. Powder coat finishes are not acceptable.

1. Manufacturers:

   a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
   b. Securitron (SU) - EL-CEPT Series.
   c. Von Duprin (VD) - EPT-10 Series.

C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

   a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
   b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

   a. Hager Companies (HA) - Quick Connect.
   b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.
   c. Stanley Hardware (ST) – WH Series.

D. Provide mortar guard enclosure on steel frames installed at masonry openings for each electrical hinge specified.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

   a. Burns Manufacturing (BU).
   b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   c. Trimco (TC).

B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

a. Burns Manufacturing (BU).
b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
c. Trimco (TC).

C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers:

a. Burns Manufacturing (BU).
b. Hiawatha, Inc. (HI).
c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
d. Trimco (TC).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinders: Original manufacturer cylinders complying with the following:

1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Match Facility Standard.

D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:

1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (large format) as specified in Hardware Sets.

E. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified cylinders employing a utility patented and restricted keyway requiring the use of patented controlled keys. Provide bump resistant, fixed core cylinders as standard with solid recessed cylinder collars. Cylinders are to be factory keyed where permanent keying records will be established and maintained.

1. Provide a 6 pin multi-level master key system comprised of patented controlled keys and security and high security cylinders operated by one (1) key of the highest level. Geographical exclusivity to be provided for all security and high security cylinders and UL437 certification where specified.

   a. Level 1 Cylinders: Provide utility patented controlled keyway cylinders that are furnished with patented keys available only from authorized distribution.
   b. Level 2 Cylinders: Provide utility patented controlled keyway and side bar locking incorporating unique angled bottom pins for geographical exclusivity. Cylinders constructed to provide protection against bumping and picking.
   c. Level 3 Cylinders: Provide utility patented controlled keyway and side bar locking incorporating unique angled bottom pins for geographical exclusivity. Cylinders to be UL437 certified and constructed to provide protection against bumping, picking, and drilling.
   d. Refer to hardware sets for specified levels.

2. Manufacturers:

   a. Sargent Manufacturing (SA) - Degree Series.

F. Keying System: Each type of lock and cylinders to be factory keyed.

1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Key locks to Owner's existing system.

G. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).
4. Construction Control Keys (where required): Two (2).
5. Permanent Control Keys (where required): Two (2).

H. Construction Keying: Provide temporary keyed construction cores.

I. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

J. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

   a. Lund Equipment (LU).
   b. MMF Industries (MM).
   c. Telkee (TK).

K. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into “Key Wizard” software.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

   a. Sargent Manufacturing (SA) – 8200 Series.
   b. No Substitution.

2.7 INTEGRATED WIEGAND OUTPUT ACCESS CONTROL LOCKING DEVICES

A. Integrated Wiegand Output Mortise Locks: Wiegand output ANSI A156.13, UL294 6th Edition, CAN ULC S319, A156.25 Grade 1, mortise lockset with integrated RFID card reader, request-to-exit signaling, door position status switch, and latchbolt monitoring in one complete unit. Hard wired, motor driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt. Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.

1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Latchbolt monitoring and door position switch act in conjunction to report door-in-frame (DPS) and door latched (door closed and latched) conditions.
2. Reader supports either HID 125 kHz proximity (up to 39 bits, including Corporate 1000) or 13.56 MHz iClass®, iClass® SE, iClass® SR, iClass® Seos, MIFARE, DESFire EV1, and Seos NFC mobile credentials (including Elite, University 1000 and Corporate 1000).
3. 12VDC external power supply required for reader and lock, with optional 24VDC operation available with iClass® reader (125 kHz reader is always 12VDC). Fail safe or fail secure options.
4. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
5. Installation requires only one cable run from the lock to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
6. Support end-of-line resistors contained within the lock case.
7. Installation to include manufacturer's access control panel interface board or module where required for Wiegand output protocol.
8. Manufacturers:

   a. Sargent Manufacturing (SA) - Harmony - H1/H2 8200 Series.
   b. No Substitution.

2.8 AUXILIARY LOCKS

A. Narrow Case Deadlocks and Deadlatches: ANSI/BHMA 156.13 Series 1000 Grade 1 certified narrow case deadlocks and deadlatches for swinging or sliding door applications. All functions shall be manufactured in a single sized case formed from 12 gauge minimum, corrosion resistant steel (option for fully stainless steel case and components). Provide minimum 2 7/8" throw laminated stainless steel bolt. Bottom rail deadlocks to have 3/8” diameter bolts.

1. Manufacturers:

   a. Adams Rite Manufacturing (AD) - MS1850S / MS1950 Series.

2.9 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 ELECTROMAGNETIC LOCKING DEVICES

A. Concealed Shear Locks: Shear locks to be self-aligning magnetic type suitable for mortised mounting with minimum holding force strength of 1000 lbs. Locks to be "dual voltage” capable of accepting either 12 or 24VDC without field adjustment at the time of the installation. Electronics are to be fully sealed against tampering and allow exterior weatherproof applications. Locks can be mounted at the top or side of the door and will operate on either single or double acting doors. Power supply to be by the same manufacturer as the lock with combined products having a lifetime replacement warranty.

1. Manufacturers:

   a. Rutherford Controls (RC) – 8360 Series.
   b. Security Door Controls (SD) - Shear EMLock 1500 Series.
   c. Securitron (SU) - SAM Series.

2.11 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
6. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
7. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

8. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
9. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
10. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
11. Extended cycle test: Devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 50 million cycles.
12. Rail Sizing: Provide exit device rails factory sized for proper door width application.
13. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
14. Hurricane and Tornado Resistance Compliance: Conventional exit devices are to be U.L. listed for windstorm assemblies where applicable. Provide the appropriate hurricane or tornado resistant products that have been independent third party tested, certified, and labeled to meet state and local windstorm building codes applicable to project.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

    a. Sargent Manufacturing (SA) - 80 Series.
    b. No Substitution.

C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.

1. At openings designed for severe wind load conditions due to hurricanes or tornadoes, provide manufacturer's certified mullion and accessories to meet applicable state and local windstorm codes.
2. Provide keyed removable feature where specified in the Hardware Sets.
3. Provide stabilizers and mounting brackets as required.
4. Provide electrical quick connection wiring options as specified in the hardware sets.
5. Manufacturers:

    a. Sargent Manufacturing (SA) - 980S Series.

2.12 INTEGRATED WIEGAND OUTPUT ACCESS CONTROL EXIT DEVICES

A. Wiegand Output Integrated Card Reader Exit Hardware: Wiegand output ANSI 156.3 Grade 1 rim, mortise, and vertical rod exit device hardware with integrated proximity card reader, latchbolt and touchbar monitoring, and request-to-exit signaling, in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle exit trim with 3/4" throw latch bolt. U.L listed and labeled for either panic or "fire exit hardware" for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.

1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Inside push bar (request-to-exit) signaling and door position (open/closed status) monitoring (via separately connected DPS).
2. Reader supports either HID 125 kHz proximity (up to 39 bits, including Corporate 1000) or 13.56 MHz (2K-32K) iClass® credentials.
3. 12VDC external power supply required for reader, with optional 24VDC operation available with iClass® reader (125 kHz reader is always 12VDC). 24VDC required for solenoid operated exit trim (12VDC if applicable). Fail safe or fail secure options.
4. Installation requires only one cable run from the exit hardware to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
5. Manufacturers:

    a. Sargent Manufacturing (SA) - Harmony - H1/H2 80 Series.
    b. No Substitution.

2.13 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. Sargent Manufacturing (SA) - 351 Series.
c. Norton Door Controls (NO) - 7500 Series.

2.14 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

a. Burns Manufacturing (BU).
b. Hiawatha, Inc. (HI).
c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
d. Trimco (TC).

2.15 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they

will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

   a. Burns Manufacturing (BU).
   b. Hiawatha, Inc. (HI).
   c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   d. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

   a. Rixson Door Controls (RF).
   b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
   c. Sargent Manufacturing (SA).

2.16 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Furnished by door manufacturer, UL10C category A.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
3. Reese Enterprises, Inc. (RE).

2.17 ELECTRONIC ACCESSORIES

A. Networked Contactless Smart Card Readers: Contactless smart cards reader to securely read access control data from 13.56 MHz contactless smart cards. The contactless smart card reader is designed for use in access control applications by providing:

1. Secure access control data exchange between the smart card and the reader utilizing key diversification and mutual authentication routines.
2. Contactless smart card reader to be designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Operating voltage: 5-16 VDC. Current requirements: 55 mA Avg, 116 mA Peak at 12 VDC.
3. Universal compatibility with most access control systems and backwards compatibility with legacy 125 KHz proximity access control formats.
4. Product construction suitable for both indoor and outdoor applications.
5. Customizable behavior for indicator lights and audible tones.
6. Manufacturers (13.56 MHz iClass):

    a. Corbin Russwin Hardware (RU) - 744F709/744F719 Series.
    b. HID Global (HD) - R10/R40 Series.
    c. Sargent Manufacturing (SA) - 6100/6120 Series.

B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

    a. Sargent Manufacturing (SA) – 3280 Series.
    b. Security Door Controls (SD) - DPS Series.
    c. Securitron (SU) - DPS Series.

C. Proximity Access Cards and Credentials: RF programmable, 125 kHz access control/identification cards utilizing a passive, no battery design allowing for infinite number of reads. Cards are programmable in any HID proximity format up to 85 bits and compatible with all HID proximity readers.

1. Manufacturers (125 kHz Proximity):

    a. HID Global (HG) - ISO Prox ll Series.
    b. Sargent Manufacturing (SA) - PCH Series.

D. Wiegand Test Unit: Test unit verifies proper Wiegand output integrated card reader lock installation in the field by testing for proper wiring, card reader data integrity, and lock functionality including lock/unlock, door position, and request-to-exit status. 12 or 24VDC voltage adjustable operating as Fail Safe or Fail Secure.

1. Manufacturers:

    a. Sargent Manufacturing (SA) – WT2 Wiegand Test Unit.

E. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

   a. Sargent Manufacturing (SA) - 3500 Series.
   b. Security Door Controls (SD) - 630 Series.
   c. Securitron (SU) - BPS Series.

2.18 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

   1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

END OF SECTION 087100

SECTION 087113 - AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide automatic door operators in accordance with requirements of the Contract Documents.

B. Section Includes:

1. Low-energy door operators for swinging doors, and balanced entrance doors.
~~1.~~**2. Bollard Posts with ADA and Card-reader access.**

C. Related Requirements:

1. Division 08, Section “Door Hardware” for door hardware and operational description.
2. Division 26 Sections for electrical connections including conduit and wiring for power door operators and security devices.

1.2 DEFINITIONS

A. AAADM: American Association of Automatic Door Manufacturers.

B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.

C. Double-Egress (Doors): A pair of doors that simultaneously swing with the two doors moving in opposite directions with no mullion between them.

D. Double-Swing (Doors): A pair of doors that swing with the two doors moving in opposite directions with a mullion between them; each door functioning as a single-swing door.

E. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.

F. For automatic door terminology, see BHMA A156.10 and BHMA A156.19 for definitions of terms.

1.3 COORDINATION

A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.

B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.

C. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to power supplies and access-control system.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Include door hardware supplier and security contractor to coordinate door function and operation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For automatic door operators.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Indicate locations of activation and safety devices.
4. Include diagrams for power, signal, and control wiring.

~~4.~~C. Color Samples for selection of factory-applied color finishes.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of automatic door operator. For each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.

B. Warranty document as specified herein.

C. AAADM inspection compliance form completed and signed by certified AAADM inspector prior to doors being placed in operation as proof of compliance with ANSI A156.19.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project and who employs a Certified Inspector.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

B. Certified Inspector Qualifications: Certified by AAADM.

1.9 COORDINATION

A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.

B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.

C. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to power supplies and access-control system.

~~1.9~~1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Faulty or sporadic operation of automatic door operator, including controls.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Provide electro-mechanical, field selectable, low energy operators that comply with ANSI A156.19, and in compliance with Florida Product Approvals. Provide surface mounted low energy swing door operator. Acceptable manufacturers are:

1. Besam SW200i series
2. LCN 9540 Senior Swing
3. Gyrotech GT500 series

2.2 AUTOMATIC DOOR OPERATORS, GENERAL

A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and according to UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.

1. Emergency Breakaway: Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to automatic door operator when door is in emergency breakaway position, to return door to closed position after breakaway, and to automatically reset.
2. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
3. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load of 30 mph. Complly with Miami Dade requirements.

B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.

C. Housing for Overhead Concealed Operators: Fabricated from minimum 0.125-inch-ick, extruded or formed aluminum and extending full width of door opening including door jambs to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

D. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch-thick, extruded or formed aluminum; manufacturer's standard width; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

E. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.

F. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 LOW-ENERGY DOOR OPERATORS

A. Standard: BHMA A156.19.

B. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.

2. Entrapment-Prevention Force: Not more than 15 lbf required to prevent stopped door from closing or opening.

C. Configuration: Operator to control swinging doors.

1. Operator Mounting: Surface.

D. Operation: Power opening and power assisted spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.

1. Note: Push-N-Go feature shall be deactivated at installation.

E. Operating System: Electromechanical.

F. Microprocessor Control Unit: Solid-state controller.

G. Features:

1. Adjustable opening and closing speed.
2. Adjustable opening and closing force.
3. Adjustable backcheck.
4. Adjustable hold-open time from zero to 30 seconds.
5. Adjustable time delay.
6. Adjustable acceleration.
7. On-off /hold-open switch to control electric power to operator; key operated.
8. Provide time delay relay to coordinate with electrified hardware.

2.4 BOLLARD POSTS

A. Provide surface-mounted stainless steel bollard posts including switches, caps and all required fasteners and accessories with concealed mounting base.

B. Basis-of-Design: WIKK Industries; "Bollard SQ32" Comparable bollards by BEA or equal.

C. Features:

1. 6" x 6" x 48" tall.
2. 304 Stainless Steel in US32D (630)
3. Surface mount with concealed mounting base.
4. 2 preps for card reader and ADA switch behind Lexan glass.
5. Removable Access Panel on the back with security screws.
6. Welded Flat top.

~~2.4~~2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: ASTM B221.
2. Sheet: ASTM B209.

B. Stainless-Steel Sheet: ASTM A240 or ASTM A666, Type 304 for interior and 316 for exterior applications, stretcher-leveled standard of flatness, in manufacturer's standard thickness.

C. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

~~2.5~~2.6 CONTROLS

A. General: Provide controls, including activation and safety devices, according to BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.

B. Activation Device: Shall be located on each side of the opening as per ANSI Safety Standard A117 and shall be hardwired to door operator controls.

1. Wall Activation Switch: Manufacturer's flush type, wall-mounted activation plate, intended for push operation. Provide nominal 4.75” square stainless steel push plate (similar to LCN 8310-853T). Face plates shall be engraved with the international symbol for accessibility and “Press To Open”. Jamb or wall mounted as required. Other manufacturers as approved by Architect.

2. Operation: Generally, where doors are operated by means of activation plates, provide activation plates on both side of each door equipped with door operator.

3. Refer to Door Hardware section for description of operation of opening and coordinate with door hardware.

4. Coordinate location with Architect and Div. 26 Contractor.

C. Operation: Where doors are operated by means of push plates, provide plates on both side of each door equipped with door operator. <u>The activation of the door by the manual action feature (“Push-N-Go” shall be deactivated.</u>

~~2.6~~2.7 FABRICATION

A. Factory fabricate automatic door operators to comply with indicated standards.

B. Form aluminum shapes before finishing.

C. Fabricate exterior components to drain condensation and water passing joints within operator enclosure to the exterior.

D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.

E. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

~~2.7~~2.8 ACCESSORIES

A. Signage: As required by cited BHMA standard for type of door and its operation.

1. Application Process: Operator manufacturer's standard process.
2. Provide sign materials with instructions for field application when operators are installed.

~~2.8~~2.9 GENERAL FINISH REQUIREMENTS

A. Finish (for all exposed surfaces): Finish shall be a painted finish to match frame.

B. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.

B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.

C. Verify that full-height finger guards are installed at each door with pivot hinges where door has a clearance at hinge side greater than 1/4 inch and less than 3/4 inch with door in any position.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Installer shall be factory trained, certified by AAADM, and experienced to perform work of this section. Install door units plumb, level and true to line, without warp or rack of frames or sash with manufacturer's prescribed tolerances. Provide support and anchor in place.

B. Install automatic door operators according to manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.

1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.

C. Access-Control System: Connect operators to access-control system, coordinate with Security Contractor where required.

D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 FIELD QUALITY CONTROL

A. Certified Inspector: Engage an AAADM certified technician to inspect and adjust installation to assure compliance with ANSI A156.19 and to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and inspect each automatic door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.

C. Automatic door operators will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.

1. Adjust operators on exterior doors for weathertight closure.

B. After completing installation of automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.

C. Readjust automatic door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide one visit to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

END OF SECTION

SECTION 088000 – GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Glazed Curtain walls.
2. Glazed entrances and storefronts.
3. All Glass Partitions and Entrances.
4. Glazed windows.
5. Door Vision Lights

B. Related Sections:

1. Division 07 Section "Joint Sealants" for requirements of preconstruction compatibility and Adhesion Testing for structural sealant glazing.
2. Division 08 “Aluminum Framed Entrances.”
3. Division 08 “Interior Aluminum-Frames Storefronts.”
4. Division 08 “Glazed Aluminum Windows and Curtain Walls.”
5. Division 08 “Sloped Glazing Assemblies.”

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions.

Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. Building Code Requirements: Provide glazing assemblies and components which comply with requirements of the Florida Building Code.

B. Exterior products in this section must have Florida Product Approval.

1. Provide systems that will handle the Project-specific Wind Pressures.

C. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

D. Glass Design: Glass thickness indicated is minimums and is for detailing only. Confirm glass thickness by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thickness indicated, but not less than thickness and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thickness: Select minimum glass thickness to comply with ASTM E 1300, according to the following requirements:
   a. Specified Design Wind Loads: As indicated. Section 084413 and structural Sheets S131,S132,S133
   b. Probability of Breakage for Vertical Glazing: 8-Lites typical for Vertical and 1-Lite for sloped Glazing per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.

      1) Load Duration: 60 seconds or less.

   c. Maximum Lateral Deflection: For the following types of glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 3/4 inch, whichever is less.

      1) For monolithic-glass lites heat treated to resist wind loads.
      2) For laminated-glass lites.
      3) Insulating Glass.

E. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

F. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

~~F.~~G. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer program.
4. Solar Optical Properties: NFRC 300.

~~G.~~H. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by window-wall systems without failing adhesively or cohesively. Provide sealant that fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

~~H.~~I. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20-psi.

~~I.~~J. Glazing Sealants: As follows:

1. Compatibility and Adhesion: Glazing sealants shall be compatible with substrate materials as demonstrated through testing requirements specified in Division 7 Section "Joint Sealants", Article "Quality Assurance."
2. Temperature: Glazing sealants shall be capable of being applied to surfaces having a surface temperature range of minus 15 degrees F to plus 120 degrees F. Cured sealant shall not harden in cold, or soften in heat, when exposed to a temperature range of minus 40 degrees F to plus 300 degrees F.

1.5 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each glass product and glazing material indicated.

C. Samples: For the following products, in the form of 12-inch- square Samples for glass.

1. (3) three samples each glass type indicated.

D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thickness for each size opening and location.

1.6 INFORMATION SUBMITTALS

A. Installation Instructions: For each glass product and glazing material indicated.

B. Wind Load Analysis: Wind load analysis for each glass unit type. The analysis shall clearly indicate that the statistical probability of breakage at the design wind pressure will not exceed the specified statistical probability of breakage.

C. Thermal Stress Analysis: Thermal stress analysis for each exterior glass unit type, each building elevation. The analysis shall clearly indicate all the expected service temperature ranges and the effects of partial and full shading on the glass. Append to the thermal stress analysis a statement from the glass manufacturer that based upon this analysis that the resulting thermal stresses will not reduce the specified statistical probability of breakage.

D. Glass Manufacturers' Letter: The glass manufacturer shall submit a letter verifying that he has reviewed the glazing details proposed for the project, including the use of gaskets and sealants, and that each product to be furnished is recommended for the application shown.

E. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Universities, and other information specified.

G. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

H. Product Test Reports: From a qualified testing agency indicating the following products comply with requirements, based on comprehensive testing of current products:

1. All glass indicated.
2. Glazing sealants.

I. SWRI Validation Certificate: For each elastomeric glazing sealant specified to be validated by SWRI's Sealant Validation Program.

J. Warranties: Special warranties specified in this Section.

K. Certification: Include structural analysis of glazing signed and sealed by a professional engineer registered in the state of Florida responsible for their preparation.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

C. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
2. Glass Testing Agency Qualifications: An independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric glazing sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

E. Sound Transmission Loss:

1. Provide ASTM E90 (Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements) laboratory test reports for fixed panels and doors in operable conditions.
2. STC 45 performance for interior glazing.

~~E.~~F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

~~F.~~G. Moisture Intrusion Testing: performance testing of installed glazing systems shall be performed to verify that they are installed properly.

1. AAMA 501 – Voluntary Specification for Field Testing of Windows and Sliding Glass Doors.
2. AAMA 502 –Voluntary specification for Field Testing of Metal Storefronts, Curtain Walls and Sloped Glazing Systems.
3. ASTM E1105 –Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.

~~G.~~H. Fire Protective Rated Glass: Each lite shall bear permanent, nonremovable label of UL certifying it for use in tested and rated fire protective assemblies.

~~H.~~I. Fire Protective Glazing Products for Door Assemblies: Products identical to those tested per ASTM E2074-00 and UL 10B, labeled and listed by UL.

~~I.~~J. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glass type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants.

1. Use manufacturer's standard test methods to determine whether priming and other specific preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.

   a. Perform tests under normal environmental conditions replicating those that will exist during installation.

2. Submit not fewer than nine pieces of each type and finish of glass-framing members and each type, class, kind, condition, and form of glass (monolithic, laminated, and insulating units) as well as one sample of each glazing accessory (gaskets, tape sealants, setting blocks, and spacers).
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

~~J.~~K. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

~~K.~~L. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 degrees F.

1.10 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive University of other rights University may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Manufacturer's Special Warranty on Laminated Glass: Written warranty, made out to University and signed by laminated-glass manufacturer agreeing to furnish replacements for laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Five years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

D. Manufacturer's/Fabricator's Special Warranty on Tempered Glass: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace glass that breaks as a result of nickel sulphide inclusions at a rate exceeding 5 breaks per 1000 (a rate exceeding 0.5%), f.o.b. the nearest shipping point to Project site and pay for the costs of reasonable market replacement labor, within specified warranty period indicated below.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer and Products: Subject to compliance with requirements, provide products by the following manufacturers:

1. AFG Industries, III, Kingsport, TN. (800) 251-0441;
2. Guardian
3. McGrory
4. Oldcastle
5. Viracon Owatonna, MN, (800) 533-2080
6. Vitro Architectural Glass (formerly PPG Industries)
7. Or equal.

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."

4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

F. Glass for Heat Treatment:

1. Glass with Thermal Stress Induced by Differential Shading: Provide heat-strengthened float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in "Performance Requirements" Article.
2. Low-E Coated Glass: Provide heat-strengthened float glass for all Low-E coated vision glass (outboard lites of insulated units).
3. Ceramic-Coated Spandrel Glass: Provide heat-strengthened float glass for all ceramic-coated spandrel glass (inboard lites of insulated units).
4. Ceramic-Coated Vision Glass: Provide fully tempered float glass for all ceramic-coated vision glass (outboard lites of insulated units, and inboard lites of laminated units or laminated insulated units of sloped glazing systems).

G. Sizes and Cutting for Heat Treated Glass: Prior to heat treatment, cut glass to required sizes as determined by accurate measurement of openings to be glazed, making allowance for required edge clearances. Cut and process edges in accordance with glass manufacturer's recommendations. Do not cut or treat edges in the field.

H. Flatness Tolerances for Heat Treated Glass: All heat treated glass shall be fabricated to the following flatness tolerances:

1. Overall Bow and Warp: Maximum bow and warp tolerances in any direction as listed in ASTM C1048, Table 2. Localized warp limited to 0.03 inches in 12 inches.
2. Roll Wave: The deviation from flatness at any peak (peak to valley deviation) shall not exceed 0.003 inches in the center of lites, and shall not exceed 0.008 inches within 11.3 inches of the leading or trailing edge, for 6 mm thick glass.

I. Heat Soaking for Tempered Glass: All tempered glass shall be heat soaked in accordance with the manufacturer's recommendations. Statistical heat soaking shall not be permitted. The purpose of the heat soak destructive test is to convert nickel sulfide inclusions from the alpha phase to the beta phase to cause the glass to fracture during the test.

1. Pre-stress glass around holes to a level which is compatible with the design and use of the fittings. Check stress levels by the use of a differential surface refractometer.

2.3 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Ultraclear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent and solar heat gain coefficient of not less than 0.87.

C. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

E. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

F. Sputter-Coated Vision Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified. Pyrolytic, and wet deposition, glass coatings are not permitted.

G. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."

H. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

~~2.2~~2.4 SAFETY GLAZING

A. Safety Glazing: Provide safety glazing as required by Florida Building Code 5th Edition for hazardous locations.

1. Glazing in swinging doors.
2. Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches above the walking surface.

~~2.3~~2.5 LAMINATED GLASS

A. Laminated Glass: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified, including those in the Laminated-Glass Schedule at the end of Part 3.

B. Interlayer: Interlayer material as indicated and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

C. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

~~2.4~~2.6 INSULATING GLASS PRODUCTS

A. General:

1. Fabrication: Fabricate units at factory with sheets of glass hermetically sealed at all edges with a polyisobutylene primary and a silicone secondary elastomeric sealant. Dehydrate entrapped air and provide a desiccant on same side of each light. Insulating glass units shall be certified to meet or exceed the requirements of IGCC when tested in accordance with ASTM E2190.

   a. Fabricate units from glass types of kind indicated or, if not otherwise indicated, Kind HS (heat strengthened) where recommended by manufacturer to comply with system performance requirements specified.
   b. Spacer Specifications: Manufacturer’s standard spacer material and construction complying with the following requirements:

      1) Spacer Material: Aluminum with powdered metal paint finish in black color.
      2) Desiccant: Molecular sieve or silica gel, or blend of both.
      3) Corner Construction: Manufacturer’s standard corner construction.

   c. Interspace Content: Air.

B. Low-E Coated Insulating Vision Glass Products, General: Performance characteristics designated for coated insulating glass products are nominal values based on manufacturer's published test data for glass products 1-inch thick. U-values are expressed as BTU/hr. per sq. ft. per degree F. Apply coatings to clear float or heat-treated clear float glass of kind indicated or, if not otherwise indicated, Kind HS (heat strengthened) where recommended by manufacturer to comply with system performance requirements specified. Low E coating shall be applied to #2 surface of the insulated glass unit.

1. Sputter Coated Glass Products: Float glass with the following metallic coating applied by MSVD (magnetron sputtered vacuum deposition) after manufacture and heat treatment (if any). Pyrolytic, and wet chemical deposition, glass coatings will not be permitted:

C. Ceramic Coated Insulating Spandrel Glass Products, General: Apply ceramic coatings to clear float or heat-treated clear float glass of kind indicated or, if not otherwise indicated, Kind HS (heat strengthened) where recommended by manufacturer to comply with system performance requirements specified. Ceramic coating shall be applied to #4 surface of the insulated glass unit.

1. Ceramic Coated Glass Products: Float glass with the following ceramic frit coating applied by silk screen process after manufacture and heat treatment (if any).

D. Coating Quality: The allowable range of defects in coatings applied to glass shall be as accepted through glass sample submissions. Installed coated glass products which are outside of the accepted sample range shall be subject to rejection by the Architect. In order to reduce the possibility of glass rejection, the supplier of coated glass products shall provide glass coating production runs for the entire project from a single coating facility. The allowable range of defects are defined as follows:

1. The vision glass area is defined as the field of glass which is greater than 3 inches from the glass unit edge.

a. Pinholes: At an indoor viewing distance of 6'-0" for low E coatings:

1) Pinholes greater than 1/16-inch in diameter shall not be permitted.
2) Large clusters or close spacing of pinholes 1/16-inch and smaller shall not be permitted in the vision glass area.
3) Large clusters or close spacing of pinholes 1/16-inch and smaller may be permitted outside of the vision glass area subject to Design Consultant's acceptance.

b. Scratches: At an indoor viewing distance of 10'-0" for low E coatings:

1) Scratches smaller than 3-inches long are allowed in any glass area.
2) Scratches from 3-inches to 5-inches long are allowed only within 3-inches of an edge.
3) Scratches greater than 5-inches long shall not be permitted in the vision glass area.
4) Concentrated scratches, scuffs, rub marks, cup marks or abraded areas shall not be permitted in any glass area.

c. Reflectance and Transmission Inspection: When viewed outdoors against a bright uniform opaque background at a distance of 10'-0" for low E coatings, color, reflectance and transmission will be permitted to have a slight variance subject to Design Consultant's acceptance.

1) Mottling and streaking of the coating shall not be permitted.

~~2.5~~2.7 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to UL , for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.

1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test.

B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to UL. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F temperature-rise limitation; and the fire-resistance rating in minutes.

C. Laminated Ceramic Glazing: Laminated glass made from two plies of clear, ceramic glass; 8-mm total thickness; and complying with 16 CFR 1201, Category II. Laminated glass shall be fire-rated for up to 3-hours with hose stream test, and polished on both surfaces.

1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

    a. Pilkington
    b. SAFTI FIRST Fire Rated Glass and Framing.
    c. (Basis of Design) Technical Glass Products; FireLite Plus, Premium Grade.

~~2.6~~2.8 GLAZING GASKETS

A. Dense Compression Gaskets: Continuous extruded silicone with cross sectional profile, physical properties, and cross sectional fabrication tolerances as recommended by the window wall manufacturer, and as required, to comply with the system performance requirements specified and shown all in compliance with the applicable provisions of ASTM C1115.

B. Soft Compression Gaskets: Continuous extruded expanded foam with cross sectional profile, physical properties, and tolerances as recommended by the window wall manufacturer, and as required, to comply with the system performance requirements specified and shown all in compliance with the applicable provisions of ASTM C509, Option II, Type II.

C. Corners: Factory molded.

D. Continuous Structural Gaskets/Spacers: Continuous extruded silicone or silicone compatible rubber, with cross sectional profile, physical properties, and tolerances as recommended by the sloped glazing system manufacturer, and as required, to comply with the system performance requirements specified and shown. Gaskets/Spacers shall be tested for compatibility with silicone sealants and shall be subject to the acceptance of the sealant manufacturer.

~~2.7~~2.9 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Design Consultant from manufacturer's full range.

B. Glazing Sealants: As recommended by manufacturer for joint type and as follows:

1. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in window-wall systems indicated.

    a. Color: Black.
    b. Type: Single component.
    c. Minimum Tensile Strength: 120-psi.

d. Modulus of Elasticity: As required by structural-sealant-glazed curtain-wall system design to meet performance requirements.

e. Products: One of the following or equal:

1) Dow Corning Corporation; 995.
2) GE Silicones; UltraGlaze SSG4000.
3) Tremco; Proglaze SG.

2. Weatherseal Sealant: ASTM C 920 for Type S (single component), Grade NS (nonsag), Class 25, Uses NT (nontraffic), G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other system components with which it comes in contact; and recommended by structural- and weatherseal-sealant and window-wall manufacturers for this use.

a. Joint Movement Capability: Accommodates a 50 percent increase or decrease in joint width at time of application when measured according to ASTM C 719.
b. Color: Matching structural sealant.
c. Products: One of the following or equal:

1) Dow Corning Corporation; 795.
2) GE Silicones; UltraGlaze SSG4000.
3) Tremco; Spectrem 2.

3. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

C. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.

~~2.8~~2.10 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

~~2.9~~2.11 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces.

C. Grind smooth and polish exposed glass edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system. Minimum required face or edge clearances.
3. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Inspect each piece of glass immediately before installation. Do not install any pieces which are improperly sized or have damaged edges, scratches or abrasion or other evidence of damage. Remove labels from glass immediately after installation.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

1. Structurally Glazed Insulating Glass Units: Set full length continuous structural gaskets/spacers to framing members of the window and curtain wall systems. Set glass units with void between edge of units and framing members, but with units fully within framing member rebate so as to provide a minimum 1/2 inch bite. Align glass unit edges over framing members continuous structural gasket/spacers and secure with manufacturers recommended temporary cleats. Structurally seal glass unit to framing

members with specified one-part structural silicone sealant to provide a minimum 1/4 by 1/4 inch bead of sealant. Tool structural silicone perpendicular to face of interior glass light; remove excess structural silicone from glass and metal substrates. After full cure of structural silicone sealant remove temporary cleats. Any holes left in the framing members which were caused by the temporary cleats shall be sealed immediately.

2. The installation of each light of exterior glass shall be watertight, airtight, and capable of withstanding temperature changes, wind loading, and impact from operation (doors) without failure of any kind including loss or breakage of glass, failure of seal, exudation of sealant and excessive deterioration of glazing materials.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where the length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 5/8-inch minimum bite at base with laminated units of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Install glazing gaskets in accordance with manufacturers instructions to provide a continuous watertight and airtight seal at corners and other locations where joints are required.

C. Where wedge-shaped gaskets are driven into one side of channel to pressurize gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

D. Field vulcanize corner joints of gaskets. Where installation procedures do not permit field vulcanizing, miter cut glazing gaskets at corner joints and join with a sealant recommended by the gasket manufacturer which will provide an airtight and watertight seal at the joint.

E. Install gaskets so they protrude past face of glazing stops.

3.5 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

D. Glazed Monolithic and Laminated Glass Units (Butt Glazing): Glass to glass glazing shall be in accordance with the recommendations of sealant and glass manufacturers and shall include the following.

1. Mask both sides of each adjacent piece of glass to be glazed.
2. Provide wood dowel, with a diameter of at least 3 times of the joint width, wrapped in polyethylene and firmly taped to interior face of glass to act as a back-up during glazing operations.
3. Tool face of sealant slightly concave using extreme care not to chip or otherwise abrade corners of glass.
4. Allow sealant to fully cure before removing wood polyethylene wrapped dowel.

3.6 PROTECTION AND CLEANING

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

3.7 INSPECTION

A. Owner may engage field inspection and testing agency to observe, document, and report the ongoing installation procedures.

3.8 EXTERIOR GLAZING SCHEDULE

A. NOTE:
1. Provide tempered glass where safety glazing is required.
2. All Exterior lites to be heat-strengthened.

B. **XGL01** – (Basis of Design) Guardian: 1” IGU,

1. Exterior Lite: 1/4” Clear – Tempered
2. Coating: Silver 20 - On #2 surface
3. Interspace & silicone: 1/2” air space, aluminum, black painted, 100% Air filled, black silicone
4. Interior Lite #1: 1/4” Clear - Heat Strengthened (HS)

C. **XGL02** – (Basis of Design) Guardian: 1” IGU,

1. Exterior Lite: 1/4” Clear – Tempered
2. Coating: SNX ~~51~~62/2~~3~~7 - On #2 surface
3. Interspace & silicone: 1/2” air space, aluminum, black painted, 100% Air filled, black silicone
4. Interior Lite #1: 1/4” Clear - Heat Strengthened (HS)

D. **XGL03** – (Basis of Design) Guardian: 1” IGU w/ Backpan~~Shadow Box~~,

1. Exterior Lite: 1/4” Clear – Tempered
2. Coating: Silver 20 - On #2 surface
3. Interspace & silicone: 1/2” air space, aluminum, black painted, 100% Air filled, black silicone
4. Interior Lite #1: 1/4” Clear - Heat Strengthened (HS)

E. **XGL04** – (Basis of Design) Guardian: 1” IGU, Spandrel

1. Exterior Lite: 1/4” Clear – Tempered
2. Coating: Silver 20 - On #2 surface
3. Interspace & silicone: 1/2” air space, aluminum, black painted, 100% Air filled, black silicone

4. Interior Lite #1: 1/4” Clear - Heat Strengthened (HS)
5. Coating: Warm Gray Frit 100% Full Coverage - On #4 surface

3.9 GLASS TYPES - INTERIOR

A. Glass Types - General: Provide glass types fabricated of the glass products indicated.

1. Select products to comply with performance requirements indicated, in accordance with manufacturer's recommendations.
2. Interior glass thickness: 6 mm (l/4 inch nominal), unless otherwise indicated.
3. Fabricate glass with bite and edge clearance dimensions, including tolerances, as recommended by manufacturer and FGMA "Glazing Manual."
4. Where safety glazing is required by governing authorities, provide certified safety glazing.
5. Cut tempered glass to size and shape and drill holes prior to tempering.
6. Grind exposed edges smooth, using methods recommended by manufacturer.

B. Glazing Type GL11: Clear tempered glass.

1. Thickness: 1/4” nominal.

C. Glazing Type GL12: Clear tempered glass.

1. Thickness: 9/16” nominal.

D. Glass Type GL13: Clear tempered glass.

1. Thickness: 1/4” nominal Insulated Double Pane

E. Glazing Type GL14: Clear tempered glass. (Fire Rated)

1. Thickness: 9/16” nominal

F. Glass Type GL15: Clear tempered glass. (Fire Rated)

1. Thickness: 1/4” nominal Insulated Double Pane

END OF SECTION 088000

SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide the Work of this Section in accordance with requirements of the Contract Documents.

B. Section Includes:

1. Monolithic Glass Mirrors

C. Related Sections include the following:

1. Division 08 Section "Glazing" for other glass types.
2. Division 08 Section "Glass Paneling" for mounting and supports.

1.2 DEFINITIONS

A. Deterioration of Mirrors: Defects developed from normal use that are attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
2. Mirror hardware
3. Mirror mastic.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work. Show mirror joint locations

C. Samples: For each type of mirror product required, in the form indicated below:

1. Mirrors, 12 in. square, including edge treatment on 2 adjoining edges.
2. Mirror clips
3. Mirror trim, 12 in. long.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Product Certificates: For each type of mirror and mirror mastic, signed by product manufacturer.

C. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint and substrates on which mirrors are installed.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed mirror glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in mirror installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under NGA's Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Source Limitations for Mirrors: Obtain mirrors from one source for each type of mirror indicated.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from one source for each type of accessory indicated.

D. Glazing Publications: Comply with the following published recommendations:

1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors".

E. Safety Glazing Products: For laminated and tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.8 WARRANTY

A. Special Warranty: Mirror Manufacturer and installer agree to replace mirrors that deteriorate, within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide mirrors that will not fail under normal usage. Failure includes glass breakage and deterioration attributable to defective manufacture, fabrication, and installation.

2.2 SILVERED FLAT GLASS MIRROR MATERIALS

A. Clear Glass Mirrors: ASTM C 1503;

1. Nominal thickness 1/4 inch thick unless otherwise shown or specified.
2. Provide silvering, copper backing and protective heat catalyzed paint coating on entire back surface of mirror.
3. Exposed edges of mirrors shall have a flat polished (eased) profile. Perform edge treatment and sealing in factory immediately after cutting to final sizes. Do not cut or treat edges in the field.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Mirror Mastic: An adhesive setting compound, manufactured specifically for setting mirrors by spot application, certified as compatible with back of mirror coating by organic protective coating manufacturer, scheduled mirror substrate and approved by mirror manufacturer. Comply with mirror mastic manufacturer's written instructions for size, number and pattern of mastic spots required for installation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

   a. Gunther Mirror Mastics.
   b. Palmer Products Corporation.
   c. Glazers Choice, Inc.
   d. CR Lawrence, Co., Inc.

2. Adhesive shall have a VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mirror Edge Sealer: A mirror edge sealer manufactured specifically for sealing mirror edges and that has proven to be compatible with mirror coating and approved by mirrored glass manufacturer for use in protecting against silver deterioration at mirror edges; Provide one of the following or equal:

1. "Seal-Kwik" (C. Gunther Co.).
2. "No. 209 Mirror Edge Sealant" (Sprayway, Inc.).

2.4 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Provide custom J-channels as indicated.
2. Finish: Clear anodized.

B. Top and Bottom Stainless Steel J-Channels: Cold rolled stainless steel with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.

1. Bottom Trim: J-channels formed with front leg and back leg not less than 1/2 in. and 3/4 inch in height, respectively.
2. Top Trim: Formed with front leg with a height of 1/2 inch and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
3. Product: Subject to compliance with requirements, provide the following:

a. Bottom Trim: similar to C. R. Laurence Co., Inc.; D638 FHA Type "J" Channel; except brushed stainless steel or equal.
b. Top Trim: similar to C. R. Laurence Co., Inc.; D 1638 Top Channel; except brushed stainless steel or equal..
c. Cleat: C. R. Laurence Co., Inc.; D 1637M Mirror Mount System Cleat or equal..

C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

D. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

A. Mirror Sizes: To suit Project conditions. Cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Beveled polished edge of width shown.

1. Seal edges of mirrors after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

D. Mirror Fabrication: Provide shop fabricated panel assembly, including mirror, mastic, backer boards, angle trim, with necessary accessories, fasteners, and components required for a complete installation.

1. Cores: Plywood backer boards for glass paneling as specified in Division 08, Section Glass Paneling". Touch sand and prime paint with system compatible with adhesive used to mount mirrors and glazing to plywood backerboards and specifically fabricated for this application.
2. Support mirror panels with stainless steel satin finished angle frame, with bottom support designed to withstand glass weight. Provide 1/8 in. thick by 4 in. long x 1/4 in wide silicone setting blocks at quarter points above stainless steel anchors to separate metal from glass contact. Fabricate frame with mitered corners and polished exposed edges.

3. Apply mastic utilizing special tool to assure complete and accurate coverage. Do not cover more than 25% of glass back. Provide neoprene shims, double face tape, or other type compatible material to allow for minimum clearances for mastic.
4. Apply glass to plywood backerboards so that areas not covered with mastic will remain open for ventilation, with minimum clearance from substrate as recommended. Provide temporary rigid support until adhesive has set.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance.

1. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
2. Proceed with mirror installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Mirror Installation: Install shop fabricated glass panels to comply with manufacturer's written instructions, referenced standards, and details on approved shop drawings

1. Avoid filed cutting or notching of factory cut panels. Minimize field drilling, cutouts and follow manufacturer's recommended procedures where this work is unavoidable.
2. Install panels plumb, true to line, level and with joints in uniform width accurately aligned.
3. Attach Z-clips securely to backs of plywood panels and wall surfaces with mechanical fasteners, with anchors or inserts as applicable. Use fasteners of depth necessary to secure Z-clips to plywood, without imposing point loads on backs of glass.
4. Butt adjacent panels without lapping. Maintain uniform joints in alignment across entire elevation.
5. Apply continuous bead of sanitary silicone sealant bottom of panels and wall/backsplash as well as at sides of mirror panels to seal edges and protect silver backing from water moisture damage. Maintain vents at top of panels to allow for air circulation.

3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Aluminum louvers for exterior applications.

B. Related Sections:

1. Division 07 “Aluminum Composite Metal Panels.”

2. Division 08 “Glazed Aluminum Window and Curtain Walls.”

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

A. Florida Product Approval: Louvers must meet Florida Product Approval requirements.

B. Structural Design - Wind Loads: Comply with the Code.

C. Thermal Movements: Provide louvers and grilles that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): Local conditions.

D. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 ACTION SUBMITTALS

A. Product Approval: Provide Florida Product Approval for louvers indicated.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For louvers, grilles, and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

1. For installed louvers and grilles indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of metal finish required.

1.6 INFORMATION SUBMITTALS

A. Qualification Data: For professional engineer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.7 QUALITY ASSURANCE

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Source Limitations: Obtain louvers and grilles through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code--Aluminum."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

E. UL and NEMA Compliance: Provide motors and related components for motor-operated adjustable louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Acceptable Manufacturers providing products that comply with requirements include the following or equal:

1. (Basis of Design) Construction Specialties.
2. Acceptable manufacturers:
   a. Greenheck
   b. Ruskin

2.2 LOUVERS FOR EXTERIOR APPLICATIONS

A. Hurricane Louver, Stationary Blade, Miami Dade Approved, Wind driven rain (WDR) type.

1. Model and Manufacturer – Basis of Design: CS Architectural Louvers; Model number DCH-5704.

   a. 5" Deep Horizontal Blade Extruded Aluminum, Wind Driven Rain, Impact and Structural Hurricane, Louver.

   b. Miami Dade NOA: No. 19-0305.01
      1) Expiration date: June 2024

2. Locations: As indicated on drawings.

B. Physical Properties and Fabrication:
   1. Integral caulking slot and retaining beads. Blades to be one-piece aluminum extrusions with front lip gutter and secondary gutter designed to catch and direct water to sill. Louvers to be supplied with 4” (101.6mm) high by full depth sill flashings formed from minimum 0.050” (1.27mm) thick aluminum.

2. Sill flashings to have welded side panels.
3. Louvers and sill flashings to be installed in accordance with the manufacturer's recommended procedures to ensure complete water integrity performance of the louver system.
4. Material minimum thickness to be as follows:
   a. Heads and sills: 0.075" (1.905mm), jambs and mullions: 0.081" (2.06mm), fixed blades: 0.060" (1.52mm).
5. Structural Performance: Louvers shall be in compliance with Florida Product Approvals for Impact Resistant Shutters and for wind loading as indicated on drawings.

C. AMCA Performance: A 4' x 4' unit shall conform to the following:
   1. Free Area 7.32 sq. ft.
   2. Free Area Velocity at Beginning Point of Water Penetration 1169 ft/min (5.94m/s)
   3. Intake Pressure drop at 900 fpm free area velocity (4.57 m/s) 0.134 in. H2O (33.38 Pa)
   4. Exhaust pressure drop at 900 fpm free area velocity (4.57 m/s) 0.167 in. H2O (41.6 Pa)

D. Wind Driven Rain Performance: The louver test was based on a 39.370"(1.00m) x 39.370" (1.00 m) core area. Unit tested at a rainfall rate of 3.0 inches per hour (75 mm/hr) and with a wind directed to the face of the louver at a velocity 29.1-mph (13 m/s) as well as a rainfall rate of 8.0 inches per hour (203mm/hr) and a wind of 50-mph (23.3m/s).

2.3 MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.

D. Clip Angles: Structural grade aluminum.

E. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel. Do not use metals that are incompatible with joined materials.

   1. Use types and sizes to suit unit installation conditions.

F. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

2.4 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Maintain equal louver blade spacing to produce uniform appearance.

E. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

F. Include supports, anchorages, and accessories required for complete assembly.

G. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 incheson center, whichever is less.

1. Fully Recessed Mullions: Provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.

H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

I. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.5 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location: Interior face.
2. Screening Type: Bird screening.

B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert for securing screen mesh.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening: Stainless steel, 1/2-inch-0.047-inch

E. Uninsulated, Blank-off Panels for Louvers:

1. Aluminum sheet for aluminum louvers, not less than 1.2-mm nominal thickness, unless otherwise indicated.
2. Panel Finish: Same finish applied to louvers.
3. Attach blank-off panels to back of louver frames with stainless-steel, sheet metal screws.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

2.7 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic Finish (2-Coat Fluoropolymer to match Curtain Wall): AA-C12C40R1x; 2-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match Curtain Wall.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and grilles level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and grilles that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and grilles damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

E. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089000

SECTION 092100 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes, but is not limited to:

1. Nonload-bearing steel framing members for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
3. Interior gypsum board.
4. Mold and mildew resistant interior gypsum board panels attached to steel framing.
5. Exterior gypsum board for ceilings and soffits.
6. Impact resistant drywall
7. Tile backing panels attached to steel framing.
8. Monolithic Sound Absorbing Gypsum Board System

B. Related Sections:

1. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs.
2. Division 06 Section "Metal Fabrications" for steel plate blocking located in walls and load bearing steel framing.
3. Division 06 Section "Rough Carpentry" for fire retardant treated wood blocking.
4. Division 06 Section "Sheathing" for gypsum sheathing for exterior walls.
5. Division 07 Section "Thermal Insulation", for insulation.
6. Division 07 Section "Penetration Firestopping" for penetrations of fire rated walls.
7. Division 07 Section "Fire-Resistive Joint Systems" for head-of-wall assemblies that incorporate gypsum board shaft-wall assemblies.
8. Division 07 Section "Joint Sealants" for acoustical sealants at bottom & top of walls and
9. Division 09 Section "Acoustical Plaster System" for acoustical plaster adhered to GWB.
10. Division 09 Section "Interior Painting" for application of primers and finish coats.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

B. Nomenclature: Framing products provided under this Section are indicated on the Drawings as "steel studs." Structural framing specified in Division 05 Section "Cold Formed Metal Framing" is indicated on the Drawings as "CFMF or Cold Formed Metal Framing."

1.4 PREINSTALLATION MEETINGS

A. Pre-installation Meeting: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures for installing work related to gypsum board assemblies including, but not limited to, the following:
   1. Fasteners proposed for anchoring steel framing to building structure.
   2. Sprayed fire-resistive materials applied to structural framing.
   3. Elevator equipment, including hoistway doors, elevator call buttons, and elevator floor indicators.
   4. Wiring devices in gypsum board assemblies.
   5. Doors and other items penetrating gypsum board assemblies.
   6. Items supported by gypsum board assembly framing.
   7. Mechanical work enclosed within gypsum board assemblies.
   8. Ceiling assembly construction when required for lateral support of partitions.

1.5 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of product specified including related accessories. Furnish a material list with technical data documenting the location and primary function, quality, and performance of each material component or system to be used in the Work, or other such primary characteristics as required by the Drawings or Specifications.

B. Shop Drawings: Submit detailed shop drawings, including plans, elevations, sections, details of components, and attachments to other units of Work, indicating the following:

   1. Details of unusual conditions in connection with gypsum drywall construction.
   2. Proposed locations of control joints, and expansion joints that are required but not shown.
   3. Locations of access doors occurring in gypsum drywall construction.
   4. Details of attachment to primary ceiling supports.
   5. Details of rated assemblies with copies of their respective approvals. Coordinate with Division 07, Section "Fire Resistive Joints" to provide combined submittals for partition head details and penetration details at rated partitions.

C. Gypsum Board Location Schedule: Submit for Architect’s information. Provide a gypsum board location schedule utilizing the same room designations shown on Drawings listing special gypsum board types, thicknesses of partitions, composition of assemblies, and any special requirements if any, for each room scheduled for special gypsum drywall installation.

D. Samples: For the following products:
   1. Trim Accessories: Full-size Sample in 12-inch-(300-mm-) long length for each trim accessory indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

   1. Ceiling-mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; access panels; and special moldings at walls, column penetrations, and other junctures of gypsum board ceilings with adjoining construction.
   2. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).

B. Certificates:

1. Certification signed by manufacturer of gypsum board assembly components certifying that their products comply with specified requirements, comply with UL designations shown and are approved for use by local authorities having jurisdiction.

C. Evaluation Reports:

1. For firestop tracks, from ICC-ES.
2. For EQ studs, from ICC-ES

D. Acoustical-Test-Response Reports: From a qualified independent testing agency substantiating required STC rating for each gypsum board and shaft wall assembly that carry an acoustic rating.

1.7 QUALITY ASSURANCE

A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, unless otherwise indicated.

B. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

C. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

D. Installer Qualifications: The gypsum board work shall be performed by a firm having five (5) year experience in the application of gypsum board and shaft wall assemblies on projects similar in size and scope to this Project.

E. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for each level of gypsum board finish indicated for use in exposed locations.
2. Provide mockup of finishing procedures on paperless wallboard products, including one primer coat of paint.
3. Mockup one penetration (duct, light fixture) through gypsum board. Show finishing of edges.
4. Tile backer panels at one wall where Large Format Tile will be installed.
5. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
6. Simulate finished lighting conditions for review of mockups.
7. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

C. Handle gypsum boards to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal trim and framing components.

D. Store and handle gypsum panels in a manner to prevent mold growth on panels.

E. Comply with requirements of Gypsum Association Publications GA 801 (Handling and Storage of Gypsum Panel Products); GA 238 (Guidelines for Prevention of Mold Growth on Gypsum Board) and GA-220 (Gypsum Board Winter Related Installation)

1.9 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

D. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.

E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design requirements:

   1. Drawings of metal support system assemblies are diagrammatic and show design intent of finished profiles, shapes and forms; relationships between elements; location, identification, dimension and size of components, assemblies and accessories; and details and diagrams of connections.
   2. Based on stud spacing indicated on drawings, engineer, fabricate, assemble and install metal support systems to meet or exceed the criteria indicated and specified, to conform to the profiles indicated and to other requirements of the Contract Documents, to comply with requirements of the latest "SSMA Product Technical Guide" and ASTM C754 as well as applicable governing codes and regulations, and to provide structurally sound assemblies.
      a. For shaft wall assemblies provide design based on manufacturers systems.

b. Walls shown in section may exceed floor to floor specified in the SSMA Product Technical Guide", and walls may support large, heavy monitors, sign bands, wall panels. Studs for these applications shall be sized and gaged via delegated design by the Contractor's licensed Professional Engineer to support imposed loads and comply with deflection limits specified in structural performance below.

c. Where drywall is required to support imposed loads of wall and ceiling mounted items, coordinate with trades providing that work, to obtain imposed loads for engineering of gypsum wall board assemblies. These requirements include but are not limited to

1) Miscellaneous metal supports specified in Division 05, Section "Metal Fabrications",

2) Handrails and railing supports specified in Division 05 Sections "Pipe and Tube Railings", "Metal Stairs", "Decorative Metal Railings and Screens",

3) Decorative Metal and Woodwork items specified in "Decorative Metals", "Decorative Formed Metal", Division 06 Section "Architectural Woodwork".

4) Other Sections that rely on gypsum board assemblies for primary support.

B. Structural Performance: Provide steel framing capable of supporting specified gypsum board panels and withstanding design loads within limits and under conditions indicated.

1. Unless otherwise indicated, design and install gypsum board assemblies to ensure that the completed assembly withstands a minimum positive and negative pressure of 5 lbf/sq. ft. (239 Pa) normal to the plane of the wall.

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Interior Non-load-Bearing Wall Framing with Indicated Panels:

1) With Standard Gypsum Board: Horizontal deflection of L/240 of the wall height under dead load and a minimum positive and negative pressure of 5 lbf/sq. ft. (239 Pa).

2) With Standard Gypsum Board Scheduled to Receive Ceramic Tile Finishes: Horizontal deflection of L/360 of the wall height under dead load and a minimum positive and negative pressure of 5 lbf/sq. ft. (239 Pa).

3) With Tile Backing Panels: Horizontal deflection of L/480 of the wall height under dead load and a minimum positive and negative pressure of 5 lbf/sq. ft. (239 Pa).

b. Deflection, Support Framing Shaft wall Systems: Deflection of shaft wall systems shall be limited to L/240 of the span in height. In areas where room side finish is veneer plaster, lath and plaster or ceramic tile, deflection of shaft wall systems shall be limited to L/360 of the span in height.

c. Ceiling Framing with Standard Gypsum Board: Vertical deflection of 1/360 of the span of the greatest ceiling dimension under dead load and a vertical live load of 10 lbf/sq. ft. (478 Pa).

d. Shaft Wall Assemblies Surrounding Horizontal Duct Enclosures: Design and install horizontal duct enclosures to safely span between supports indicated within the following deflection limits: Horizontal deflection of L/240 of the enclosure between supports.

3. Design and install gypsum board assemblies enclosing functions including, but not limited to, stair towers, plenum and air shafts, and interior atria so that the completed assembly will withstand a minimum positive and negative pressure of 10 lbf/sq. ft. (478 Pa) normal to the plane of the wall.

a. Wall partitions surrounding stair enclosures shall be designed to meet the required pressure of 10psf (478 Pa), shall be spaced at16 inches on center with 18 gage steel studs where applicable to meet the limiting height of the wall. .

b. Loading Criteria for Partitions Surrounding Elevators Shafts: Design and install elevator gypsum shaft wall enclosure components so that the completed system will

withstand the minimum inward and outward air pressure recommended by the elevator manufacturer, but in no case less than 10psf (478 Pa) while maintaining an airtight and smoke-tight seal.

4. At partitions indicated to support large format tiles (defined in the TCNA as stone, porcelain, glass, and other tiling with at least one dimension greater than 16 inches(406mm) provide minimum 33 mils (20 gage structural) steel studs max. 16 inches(406mm) on center, with studs vertically braced 4 ft (1219 mm). o.c. for full height of partition except if limiting height requires heavier mil thickness as follows;
   a. Design, engineer, fabricate and install partition with mil thickness of structural quality and depth required to comply with floor to floor limiting heights and a maximum deflection of L/360 or 1/2 inch at mid span, whichever is more severe.
   b. At walls where stone is indicated to be installed with grout and adhesive, provide horizontal reinforcing to limit deflection to L/720 or maximum of 1/4 inch (6mm) at midspan, whichever is more severe.
      1) In addition coordinate with miscellaneous metal fabrication for provision of steel lintels every 10 ft. (3048mm) on walls to carry back weight of stone panels to structural substrate.
5. Finished installation shall be smooth and flat not to exceed 1/8 inch in 10 ft. (3mm in 3048mm), noncumulative along entire run of partition. If not in compliance with this requirement, tile installer must correct before proceeding with installation
6. Where non-structural metal studs specified in this section cannot comply with performance requirements specified or are not on the SSMA charts for floor to floor limiting heights, use non-load bearing cold formed metal framing specified in Division 05 Section "Cold Formed Metal Framing" to support partitions, suspended ceilings and imposed loads of finishes and equipment.

A. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory", GA or other approved tested assemblies. Where no test number is referenced, utilize and submit a tested approved assembly that achieves the fire rating required by the Drawings, including the Life Safety Plan.
   1. Assemblies listed do not necessarily indicate all assemblies that may be used in this project. Contractor may propose alternate UL listed assemblies that meet the same requirements to the Architect for consideration. Contractor may not substitute assemblies without written authorization by the Architect.
   2. Drawings, keys or written descriptions located in the Contract Documents to describe fire rated assemblies for beams, floors, roofs, columns, walls, partitions and through-penetration firestop systems do not necessarily call out each and every specific requirement of the designated UL listed assembly identified. It is the Contractor’s responsibility to become thoroughly familiar with the corresponding requirements published in the most recent issue of the Underwriters Laboratories Inc. Fire Resistance Directory and construct the fire rated assemblies in strict accordance with those requirements.

C. Wall Identification: In accordance with FBC, permanently label fire rated walls, fire partitions, smoke barriers and smoke partitions and any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76mm) high and with minimum 0.375 inch (10 mm) strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet

D. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

1. STC-Rated Assemblies: Indicated by design designations from GA-600, "Fire Resistance Design Manual."
2. STC Rating: As indicated on the drawings.

2.2 INTERIOR GYPSUM BOARD

A. Panel Material Requirements: Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
   1. Provide auxiliary materials complying with gypsum board manufacturer's written recommendations.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. CertainTeed Corp.
   2. Continental Building Products (formerly Lafarge)
   3. Georgia-Pacific Gypsum LLC.
   4. National Gypsum Company.
   5. USG Corporation.

C. Mold and Mildew Resistant Gypsum Board: ASTM C1396/C1396M or ASTM C1658/C1568M with moisture- and mold-resistant core and surfaces.

   1. Product: Subject to compliance with requirements, provide one of the following:
      a. Continental Building Products, "Mold Defense Type X."
      b. Georgia-Pacific Gypsum LLC, ToughRock Mold Guard Type X Board.
      c. National Gypsum Company; "Gold Bond XP Fire-Shield Wallboard."
      d. USG Corporation, "Sheetrock Brand, Mold Tough Firecode."
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Long Edges: Tapered.
   4. Mold Resistance: ASTM G21 with a score of 0, and ASTM D3273, score of 10 as rated according to ASTM D3274.

D. Gypsum Board, Type X: ASTM C1396/C1396M or ASTM C1658/C1568M:

   1. Product: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corporation, Gypsum Board, Type X.
      b. Continental Building Products,Firecheck Type X
      c. Georgia-Pacific Gypsum LLC, ToughRock Fireguard X Gypsum Board
      d. National Gypsum Company; Gold Bond Fire-Shield Gypsum Board.
      e. USG Corporation, Sheetrock Gypsum Panels, Firecode Type X.
   2. Thickness: 5/8 inch (15.9 mm).
   3. Long Edges: Tapered.

E. Sag-Resistant Gypsum Wallboard: ASTM C 36, manufactured to have more sag resistance than regular-type gypsum board.

   1. Manufacturers providing products in compliance with requirements include:

      a. Georgia Pacific "ToughRock® CD®"
      b. Lafarge, "Sagcheck®"
      c. USG "Sheetrock® Brand Sag-Resistant Interior Gypsum Ceiling Board.
      d. Or equivalent.

2. Thickness: As indicated, or if not otherwise indicated, 1/2-inch.
3. Long Edges: Tapered.
4. Location: All gypsum board ceilings as noted on reflected ceiling plans.
5. Light gage steel framing for sag-resistant ceilings shall include hangers and wire ties sufficient to support additional weight and deflection criteria: not to exceed L/360.

F. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M or ASTM C1658/C1568M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
1. Thickness: 1 inch (25 mm).
2. Long Edges: Double bevel.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3273.
4. Product: Subject to compliance with requirements, provide one of the following:
a. CertainTeed "M2Tech Shaftliner Type X."
b. Continental Building Products, "Mold Defense Shaftliner Type X."
c. National Gypsum Company "Gold Bond Fire-Shield Shaftliner."
d. USG Corporation "Type X Sheetrock Glass-Mat Panel Mold Tough."

G. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
1. Products: Subject to compliance with requirements, provide one of the following:
a. CertainTeed Corporation, " 1/4 Flex Gypsum Board."
b. Continental Building Products, "1/4 inch Regular Drywall."
c. National Gypsum Company, "Gold Bond High Flex Gypsum Wallboard."
d. USG Corporation, Sheetrock Brand Flexible Gypsum Panels, "1/4 Panels."
2. Thickness: 1/4 inch (6.4 mm).
3. Long Edges: Tapered.

H. Gypsum Ceiling Board: ASTM C1396/C1396M. Manufactured to have more sag resistance than regular type gypsum board.
1. Products: Subject to compliance with requirements, provide one of the following:
a. CertainTeed Corporation, "Type C Gypsum Board."
b. Continental Building Products, "Firecheck Type C."
c. Georgia-Pacific Gypsum LLC, “ToughRock Fireguard C Gypsum Board."
d. National Gypsum Company, "Fireshield Type C ."
e. USG Corporation, "Sheetrock Firecode Type C."
2. Core: 5/8 inch (15.9 mm).
3. Long Edges: Tapered.
4. Applications: Dry interior gypsum board ceilings that are scheduled to be painted, unless otherwise indicated.

I. Abuse-Resistant Gypsum Board: High density, fire resistant, type X core, with heavy paper face that is highly resistant to scuffing, tested in accordance with ASTM C1629/C1629M.
1. Product: Subject to compliance with requirements, provide the following or comparable product by one of the named manufacturers:
a. CertainTeed Corporation, Extreme Abuse Resistant Type X Gypsum Board.
b. Georgia-Pacific Gypsum LLC, ToughRock Fireguard Z Mold Guard Max Abuse-Resistant Gypsum Board.
c. National Gypsum Company, Hi-Abuse XP Wallboard.
d. USG Corporation, Sheetrock Brand, Mold Tough AR Firecode Panels.
2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
5. Location: Dry interior gypsum board partitions in high traffic areas as indicated on the Drawings.

J. Impact-Resistant Gypsum Board: High density, fire resistant, type X core, reinforced with a fiberglass mesh to provide impact/penetration resistance in accordance with ASTM C1629/C1629M, Level 2.
   1. Product: Subject to compliance with requirements, provide the following or comparable product by one of the named manufacturers:
      a. CertainTeed Corporation, Extreme Impact Resistant Type X.
      b. Georgia-Pacific Gypsum LLC, ToughRock Fireguard X Mold Guard Max Impact Resistant Gypsum Panel.
      c. National Gypsum Company, Hi Impact XP Wallboard.
      d. USG Corporation, Sheetrock Brand Glass-Matt Panels, Mold Tough Very High Impact Fire code Type X.
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Long Edges: Tapered.
   4. Location: Dry interior gypsum board partitions in cores surrounding stair wells and elevator shafts that are not enclosed with shaftwall or CMU.

1.2 MONOLITHIC SOUND ABSORBING GYPSUM BOARD SYSTEM

A. Description: Sound Absorbing Gypsum Ceiling and Suspension System.

B. Manufacturers and Products:

   1. (Basis of Design) USG Interiors, LLC; , USG Ensemble Acoustical Drywall Ceiling".
   2. Additional manufacturers include:

      a. Baswa
      b. CertainTeed Commercial Ceilings
      c. Knauf Danoline

C. (Basis of Design) Product Characteristics:

   1. Perforated non-fire rated gypsum panel with acoustically transparent scrim: complies with ASTM C1396 Non-Type X.
   2. Base panel is made from the following:
      a. USG Corporation, LLC**,** "USG Sheetrock® Brand EcoSmart FC 30 Ensemble™ Panels 5/8".

   3. ISO 14040 Environmental Management, Life Cycle Assessment, Principles and Framework:
   4. UL Type Designation "FC30" (prior to modifications)
   5. ASTM C 1396/C 1396M: 5/8" wallboard, non-type X (prior to modifications).
   6. ASTM E136 Non-combustibility: Meets or exceeds criteria.
   7. ASTM C473:
      a. Core Hardness: Meets or Exceeds 11 (ASTM C473 B)
      b. Flexural Strength (lbf).
         1) Parallel: Not less than 46.
         2) Perpendicular: Not less than 147.
      c. Nail Pull Resistance (lbf) ASTM C473 (B): Not less than 87.
   8. Thickness: 5/8 inch.
   9. Weight: 1.65-1.75 lbs./sq. ft.
   10. Long Edges: Tapered.

K. Acoustical Backer Panel: USG Interiors, LLC, "USG Ensemble™ High-NRC Backer Panel".

1. Classification: Provide un-faced acoustical panels with the following physical attributes:

    a. NRC: Not less than 0.80.
    b. CAC: Not less than 44.
    c. Edge/Joint Detail: SQ Square.
    d. Panel Thickness: 1 inch
    e. Modular Size: 16 by 48 inches
    f. Recycled Content: 66%.

D. Ceiling Panel Spray-Applied Finish

1. (Basis of Design) USG Interiors, LLC, “USG Ensemble™ Spray-Applied Finish”:

    a. Finish: Fine Finish.
    b. Color: White (standard)
    c. Color. To be selected by Design professional.

2. Classification: Provide acrylic based spray-applied finish complying with USG Ensemble™ Spray-Applied Finish.

E. Perforated Gypsum Board suspension system: complies with applicable requirements per ASTM C 645, direct-hung system composed of Index support bars and cross-furring drywall suspension tees that interlock.

F. Framing Systems:

1. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

    a. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

2. Framing System:

    a. Deflection criteria: L/240 per ASTM C635.
    b. Galvanized Steel: G40 double-web tee, hot-dipped galvanized steel.

3. Framing Members:

    a. Index support bars: ISB 109.
    b. USG Drywall Suspension system main tees: DLGW26.
    c. USG ISB Cross Brace Clip: ISBAC.
    d. Attachment devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements, if applicable.
    e. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
    f. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
    g. Size: Minimum 12 gage per ASTM C636.

G. Ceiling Panel Joint Treatment: Refer to manufacturer’s written instructions.

2.3 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corporation, ProRoc Exterior Type X Soffit Board.
      b. Georgia-Pacific Gypsum LLC, ToughRock Fireguard Soffit Board.
      c. National Gypsum Company, Gold Brand Fire-Shield Exterior Soffit Board.
      d. USG Corporation, Sheetrock Exterior Gypsum Ceiling Board, Firecode.
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

B. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corporation, GlasRoc Sheathing.
      b. Georgia-Pacific Gypsum LLC, DensGlass Fireguard Sheathing.
      c. National Gypsum Company, Gold Bond eXP, Extended Exposure Sheathing.
      d. USG Corporation, Securock Glass Mat Sheathing, Firecode.
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 TILE BACKING PANELS

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Diamond Tile Backer, Type X.
      b. Continental Building Products; Weather Defense Platinum Interior Type X
      c. National Gypsum Company, eXP, Tile Backer.
      d. USG, Durock Brand Glass-Mat Tile Backerboard
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
   4. Locations: Install on walls and ceilings in areas subject to indirect moisture such as toilet rooms and food preparation areas where final finish is predominantly ceramic tile. Non-tiled surfaces shall be prepared and painted as specified. Comply with manufacturer's written installation instructions. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.

C. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or C1325, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. National Gypsum Company, PermaBase Cement Board.
      b. James Hardie, Hardi Backer 500 board.
   2. Thickness: [5/8 inch (15.9 mm)].
   3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
   4. Locations: Install on walls and ceilings in areas subject to direct wetting such as showers, hydrotherapy rooms, and steam rooms where final finish is ceramic tile. Comply with installation requirements of ANSI A108.11.

1.3 MONOLITHIC SOUND ABSORBING GYPSUM BOARD SYSTEM

A. Description: Sound Absorbing Gypsum Ceiling and Suspension System.

B. Manufacturers and Products:

1. (Basis of Design) USG Interiors, LLC; USG Ensemble Acoustical Drywall Ceiling".
2. Additional manufacturers include:

   a. Baswa
   b. CertainTeed Commercial Ceilings
   c. Knauf Danoline

C. (Basis of Design) Product Characteristics:

11. Perforated non-fire rated gypsum panel with acoustically transparent scrim: complies with ASTM C1396 Non-Type X.
12. Base panel is made from the following:
    a. USG Corporation, LLC**,** "USG Sheetrock® Brand EcoSmart FC 30 Ensemble™ Panels 5/8".
13. ISO 14040 Environmental Management, Life Cycle Assessment, Principles and Framework:
14. UL Type Designation "FC30" (prior to modifications)
15. ASTM C 1396/C 1396M: 5/8" wallboard, non-type X (prior to modifications).
16. ASTM E136 Non-combustibility: Meets or exceeds criteria.
17. ASTM C473:
    a. Core Hardness: Meets or Exceeds 11 (ASTM C473 B)
    b. Flexural Strength (lbf).
       1) Parallel: Not less than 46.
       2) Perpendicular: Not less than 147.
    c. Nail Pull Resistance (lbf) ASTM C473 (B): Not less than 87.
18. Thickness: 5/8 inch.
19. Weight: 1.65-1.75 lbs./sq. ft.
20. Long Edges: Tapered.

D. Acoustical Backer Panel: USG Interiors, LLC, "USG Ensemble™ High-NRC Backer Panel".

1. Classification: Provide un-faced acoustical panels with the following physical attributes:

   d. NRC: Not less than 0.80.
   e. CAC: Not less than 44.
   f. Edge/Joint Detail: SQ Square.
   g. Panel Thickness: 1 inch
   h. Modular Size: 16 by 48 inches
   i. Recycled Content: 66%.

D. Ceiling Panel Spray-Applied Finish

1. (Basis of Design) USG Interiors, LLC, "USG Ensemble™ Spray-Applied Finish":

   a. Finish: Fine Finish.
   b. Color: White (standard)
   c. Color. Custom colors available 10/2018. Submit one of the following color numbers:
      1) Benjamin Moore
      2) Sherwin Williams
      3) Pantone

2. Classification: Provide acrylic based spray-applied finish complying with USG Ensemble™ Spray-Applied Finish.

2.5 TRIM ACCESSORIES

A. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C1047 and requirements indicated below:

1. Material: Galvanized steel sheet or rolled zinc or paper faced galvanized steel sheet.
2. Shapes indicated below by reference to Fig. 1 designations in ASTM C1047:
   a. Cornerbead on outside corners, unless otherwise indicated.
   b. Bullnose bead.
   c. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
   d. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.
   e. U-bead with face and back flanges; face flange formed to be left without application of joint compound. Use U-bead where indicated.
   f. One-piece expansion joint formed with V-shaped slot and removable strip covering slot opening.
   g. Curved-Edge Cornerbead: With notched or flexible flanges.
   h. Fire Rated Control Joint: "FAS-093X Fire Rated Control Joint" (CEMCO or Marino\Ware) composite control joint with intumescent tape factory applied to the back side of the joint, tested according to UL 2079 and used to relieve stresses of expansion and contraction of drywall interior partitions or ceilings running in a horizontal or vertical direction. Steel is fabricated from (G40 coating) hot dip galvanized steel complying with ASTM A653 and ASTM A1003.

2.6 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated and with maximum deflection conditions specified under Article "Performance Requirements."
   1. Steel Sheet Components: Comply with ASTM C645 requirements for metal , for steel framing, runners, studs, tracks, head joints, backing plate, channels, brackets and other steel supports, unless otherwise indicated.
   2. In areas where top of partitions are dependent on ceiling system for lateral support, coordinate design and installation to comply with the above deflection limitations.
   3. Protective Coating: ASTM A653/A653M, G40(Z120) in general areas and G60 (Z180) in wet areas, hot-dip galvanized unless otherwise indicated. G40 equivalent coatings will not be accepted.

B. Studs and Runners: ASTM C645.
   1. Steel Studs and Runners:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) CEMCO; California Expanded Metal Products Co.
         2) Marino\WARE.
         3) MBA Building Supplies.
         4) MRI Steel Framing, LLC.
         5) Phillips Manufacturing Co.
         6) Steel Network, Inc. (The).
         7) Telling Industries.
      b. Strength: 33 ksi minimum
      c. Minimum Base-Metal Thickness: [33 mils (0.912 mm) (20 gage, structural)] [43 mils (18 gage)].

d. Depth: 3-5/8 inches (92 mm) unless otherwise indicated on Drawings.
e. "Equivalent" thickness not allowed.

C. Attachments to Concrete Floor: As follows:
1. Power-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E1190 by a qualified independent testing agency.

D. Slip-Type Head Joints: Where indicated, provide one of the following coordinated with expected vertical movement:
1. Single Long-Leg Runner System: ASTM C645 top runner with minimum 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Long Leg Runner System: ASTM C645 top runners, with minimum 3-inch- (76-mm-) deep flanges in thickness not less than indicated for studs with studs friction fit into top runner and continuous bridging located within 12 inches (300mm) of the top of Studs to provide lateral bracing.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
a. Products: Subject to compliance with requirements, provide one of the following:
1) ClarkDietrich Building Systems Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies; Slotted Deflecto Track.
3) Steel Network Inc. (The); VertiTrack VTD Series.
4) Superior Metal Trim; Superior Flex Track System (SFT)
5) Marino\WARE Metal Framing; SLTY - Slotted Deflection Track

E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.
d. Steel Network Inc. (The); VertiTrack VTD Series.
e. Mariono\WARE or CEMCO; FAS Track Series.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base Metal Thickness: 54 mils(1.519-mm) (16 gage), sized as required to fasten to studs for supporting wall mounted fixtures, equipment or required for attachment of other work.
2. At partitions indicated to support gravity and pullout loads of imposed fixtures, equipment, services, heavy trim, furnishings and similar work, provide additional framing, blocking and bracing support within partitions. Where floor to floor limiting heights are exceeded, provide additional bracing at midpoint of wall.
a. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
3. Coordinate with Division 06 Section "Miscellaneous Rough Carpentry" for fire retardant treated wood blocking.

G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) (16 gage) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38 mm) unless otherwise indicated on Drawings.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C645.
   1. Minimum Base-Metal Thickness: 30 mils (0.912 mm) (20 gage).
   2. Depth: 7/8 inch (22.2 mm) unless otherwise indicated on Drawings.

I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs.

J. Cold-Rolled Furring Channels: Roll formed galvanized steel channel type, 7/8 inch deep, for wall furring and ceiling attachment, fabricated from 54 mils (1.34-mm) uncoated-steel thickness, with minimum 1/2 inch wide flanges.
   1. Depth: As indicated on Drawings.

K. Furring Brackets: Adjustable, serrated arm type of corrosion resistant steel sheet, complying with ASTM C645, with minimum uncoated steel thickness of 30 mils designed for screw attachment to steel studs and steel rigid furring channels.

L. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 3/4 inch (19 mm), minimum uncoated-metal thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated and spray fireproofing required.

M. Runner Tracks for Shaft wall: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
   1. Minimum Base-Metal Thickness: 33 mils.

N. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than 33 mils structural quality thick.

2.7 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

   1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
      a. Type: Postinstalled, chemical anchor or expansion anchor.

   2. Powder-Actuated Fasteners: Allowed.

C. Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint. Provide one of the following:

   1. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
   2. Rod Hangers: ASTM A 510/A 510M, mild carbon steel rods, 1/4 inch (6 mm) in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

1. Depth: 1-1/2 inches or as otherwise indicated on Drawings

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.033 inch or as otherwise indicated on Drawings.
b. Depth: 2-1/2 inches or as otherwise indicated on Drawings.

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.

a. Minimum Base-Metal Thickness: 0.033 inch or as otherwise indicated on Drawings.

4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical.

2.8 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C475/C475M and the recommendations of both the manufacturers of panel products and of joint treatment materials for each application indicated. Comply with all Gypsum Association and manufacturer's recommendations regarding temperature and humidity before applying joint compound and finish materials to gypsum board and paperless gypsum board.

B. Joint Tape for Gypsum Board: Pressure-sensitive or staple-attached, open-weave, glass-fiber reinforcing tape with setting-type joint compound.
1. Tile Backing Panels: As recommended by panel manufacturer.

C. Setting-Type Joint Compounds for Interior Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
1. Ready-Mixed Formulation: Factory-mixed product.
a. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
b. Topping compound formulated for fill (second) and finish (third) coats.
c. All-purpose compound formulated for both taping and topping compounds.

D. Joint Compound for Exterior Applications:
1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Tile Backing Panel Finishing Materials: Tape, joint and skim coat compounds as recommended by manufacturer or as follows:

1. Wet Non-Tiled and Painted Surfaces:

a. Base and Skim Coats: Portland cement and polymer adhesive based materials equivalent to Sto “Flexyl” or Dryvit “Genesis.”
b. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. (21 dN/cm) per ASTM E 2098; complying with ASTM D 578 and the following:
   1) Surface Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m) equivalent to Sto “Reinforcing Fiber Mesh.”
   2) Joint and Corner Reinforcing Mesh: 6 inch (150 mm) coated mesh tape equivalent to Sto “Reinforcing Fiber Mesh.”
c. Primer and Finish Coat: As specified in Division 09 Section 099100 “Painting.”

2. Tiled Surfaces:

a. Joint Tape: G-P Dens-Shield glass mesh tape or equivalent.
b. Reinforcing Mesh: 2 inch (50 mm) coated mesh tape equivalent to Sto “Reinforcing Fiber Mesh.”
c. Tile setting materials as specified in Division 09 Section 093000 “Tiling.”

2.9 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide asphalt saturated organic felt or foam gasket.

C. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

E. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

F. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20 FTR.
b. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
c. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Thermal Insulation: As specified in Division 07 Section “Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, including installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.

1. Furnish concrete inserts and other devises indicated to other trades for installation in advance of time needed for coordination and construction.

B. Sprayed Fire-Resistive Materials: Coordinate sprayed fire resistive materials with gypsum board assemblies, so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of gypsum board assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing."
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or metal z-furring channels to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing to support gypsum board assemblies, without reducing the thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

1. Isolate ceiling assemblies where they abut or are penetrated by building structure.

2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.

    a. Use deep-leg deflection track where indicated.
    b. Use proprietary deflection track where indicated.
    c. Use proprietary firestop track where indicated.

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL SUSPENDED CEILING FRAMING

A. Suspend ceiling hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Secure rod, flat and angle hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

C. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

D. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.

1. Hangers: 48 inches o.c., unless closer spacing is required to meet performance requirements.
2. Carrying Channels (Main Runners): 48 inches o.c. unless otherwise indicated.
3. Furring Channels (Furring Members): 24 inches o.c., unless otherwise indicated.

E. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.5 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.

1. Fasteners: Secure runners to substrates with fasteners spaced a maximum of 24 inches on center unless closer spacing is recommended by the framing manufacturer for the floor and ceiling construction involved. Provide fasteners at all corners and ends of runner tracks.

B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8-inch from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1/2-inch short of full height to provide perimeter relief. Do not fasten studs to top track to allow independent movement of studs and track.
2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.

a. Terminate partition framing at suspended ceilings where indicated.

D. Install steel studs and furring in sizes and at spacings indicated but not less than that required by the referenced steel framing installation standard to comply with maximum deflection and minimum loading requirements specified, unless more stringent requirements are recommended by the gypsum board manufacturer:

1. Single-Layer Construction: 16-inches o.c., unless otherwise indicated.
2. Multilayer Construction: 16-inches o.c., unless otherwise indicated.

E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, and as follows:

1. Single Doors To 32-Inches Wide: Two 0.027-inch thick studs or one 0.045-inch thick stud at each jamb and one additional stud no more than 6 inches from stud. At fire rated openings, use one 0.045-inch thick stud only.
2. Single Doors Greater Than 32-Inches To 48-Inches Wide: One 0.045-inch thick stud at each jamb and one additional stud no more than 6-inches from jamb studs.
3. Single Doors Greater Than 48-Inches Wide and All Pairs of Doors: Two 0.045-inch thick studs at each jamb and one additional stud no more than 6-inches from jamb studs.
4. Provide runner track and typical studs above door openings with studs spaced not more than 24-inches o.c.
5. At all welded frames with fixed anchor clips secure stud reinforcing to jamb anchor clips with not less than two self tapping screws per clip.

6. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

H. Install thermal insulation where shown.

3.6 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16-inch of open space between panels. Do not force into place.

E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Spot grout hollow metal door frames for all doors. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frames.

I. Form control and expansion joints with space between edges of adjoining gypsum panels.

J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8-sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch wide joints to install sealant.

K. Where chase walls are shown, provide bracing between parallel rows of studs. Unless otherwise shown, provide gypsum wallboard braces no less than 1/2-inch thick by 12-inches wide and cut to width of chase. Locate at quarter points in wall height between each pair of parallel studs. Fasten with not less than 3 screws at each stud.

L. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

M. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

N. Cut openings in wallboard for electrical outlets, piping and other penetrations. Maintain close tolerances so that edges will be covered by plates and escutcheons. Cut both face and back paper. Do not install electrical outlets back to back on opposing sides of partitions.

O. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

1. Space screws a maximum of 12-inches o.c. for vertical applications.
2. Install fasteners not less than 3/8-inch from ends or edges of wallboard sheets, spacing fasteners opposite each other on adjacent ends or edges.
3. Begin fastening from center of wallboard and proceed toward edges and corners.
4. Apply pressure on surface of wallboard adjacent to fasteners being driven to ensure that wallboard will be secured tightly to supporting members.
5. Drive fastener with shank perpendicular to face of board.
6. Drive screws with a power screwdriver as recommended by wallboard manufacturer. Set heads of screws slightly below surface of paper without cutting paper.

P. Space fasteners in panels that are tile substrates a maximum of 8-inches o.c.

3.7 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

   a. Stagger abutting end joints not less than one framing member in alternate courses of board.
   b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16-inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

C. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

1. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

E. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

F. Tile Backing Panels: Refer to Division 09 “Tiling.”

3.8 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings, and where not indicated, according to ASTM C 840 and the following in specific locations approved by Architect for visual effect:

1. A control joint shall be installed where a partition, wall, or ceiling traverses a construction joint (expansion, or building control element) in the base building structure.
2. Control joints shall be installed where a wall or partition runs in an uninterrupted straight plan exceeding 30-linear feet.
3. Control joints in interior ceilings with perimeter relief shall be installed so that linear dimensions between control joints do not exceed 50 feet and total area between control joints does not exceed 2,500-sq. ft.
4. Control joints in interior ceilings without perimeter relief shall be installed so that linear dimensions between control joints do not exceed 30 feet and total area between control joints does not exceed 900-sq. ft.
5. A control joint or intermediate blocking shall be installed where ceiling framing members change direction.
6. A control joint shall be installed where a partition, wall, or ceiling abuts a dissimilar wall or ceiling, or penetration.
7. A control joint shall be installed where partition, wall, or ceiling backup construction or framing changes within plane of partition, wall, or ceiling.
8. Control joints shall be installed where wings of "L", "U", and "T" –shaped ceiling areas are joined together.
9. Less-than-ceiling height door and window frames shall have control joints extending from both frame corners to the ceiling or shall have additional framing reinforcement at the frame corners to distribute concentrated stresses.

C. Install edge trim where edge of gypsum panels would otherwise be exposed or semiexposed. Provide edge trim type with face flange formed to receive joint compound.

D. Install aluminum accessories where indicated.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
   1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
   2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
   3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.
   4. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over the entire wall and ceiling surfaces where indicated on the Drawings. Spray-on Level 5 finish is not permitted.
      a. Locations for Level 5 finish shall be indicated on the drawings.

3.10 CLEANING AND PROTECTION

A. Clean floors of all wallboard debris and leave broom clean. Excess material, scaffolding, tools and other equipment are to be removed upon completion of the work.

B. Provide final protection and maintain conditions that ensures gypsum board assemblies remain without damage or deterioration at time of Final Completion.

   1. Provide protection and maintain conditions in a manner to prevent mold growth on gypsum panels. If mold growth occurs, replace gypsum panels; surface treatment of gypsum panels for mold removal is not permitted.

END OF SECTION 092100

SECTION 092123 -- GYPSUM BOARD SHAFT-WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Shaft enclosures.
2. Chase enclosures.
3. Stair enclosures.
4. Horizontal enclosures.

B. Related Sections include the following:

1. Division 09 "Gypsum Board Assemblies" for applying and finishing panels in gypsum board shaft-wall assemblies.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board construction not defined in this Section or in other referenced standards.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Provide gypsum board shaft-wall assemblies capable of withstanding the following air-pressure loads indicated for maximum heights of partitions, within the following deflection limits, while maintaining an airtight and smoke-tight seal:

   a. Lateral Loading: 7.5-psf.
   b. Deflection Limit: l/240 of partition height.

2. Provide gypsum board shaft-wall assemblies for horizontal duct enclosures capable of spanning distances indicated within deflection limits indicated.

   a. Deflection Limit: l/240 of the distance between supports.
   b. Allowable Steel Stress: Reduce allowable steel stress to 50% allowed by ASTM E 119.

1.5 ACTION SUBMITTALS

A. Product Data: For each gypsum board shaft-wall assembly indicated.

B. Shop drawings for shaft walls shall include the following:

1. Written confirmation and design for shaft wall construction showing its ability to withstand pressures and deflections that may occur in high velocity duct shafts/ shaft wall design prepared as an engineering shop drawing.
2. Show clearly suspension location and details and location of control and other joints.

1.6 INFORMATION SUBMITTALS

A. Fire-Test-Response Reports: From a qualified independent testing and inspecting agency substantiating each gypsum board shaft-wall assembly's required fire-resistance rating.

1. Include data substantiating that elevator entrances and other items that penetrate each gypsum board shaft-wall assembly do not negate fire-resistance rating.

B. Research/Evaluation Reports: Evidence of compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction that substantiate required fire-resistance rating for each gypsum board shaft-wall assembly.

C. Acoustical-Test-Response Reports: From a qualified independent testing agency substantiating required STC rating for each gypsum board shaft-wall assembly.

1.7 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to Authorities having jurisdiction.

1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination." Review methods and procedures for installing work related to gypsum board shaft-wall assemblies including, but not limited to, the following:

1. Fasteners proposed for anchoring steel framing to building structure.
2. Sprayed fire-resistive materials applied to structural framing.
3. Elevator equipment, including hoistway doors, elevator call buttons, and elevator floor indicators.
4. Wiring devices in shaft-wall assemblies.
5. Doors and other items penetrating shaft-wall assemblies.
6. Items supported by shaft-wall-assembly framing.
7. Mechanical work enclosed within shaft-wall assemblies.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat on leveled supports off the ground to prevent sagging.

C. Store and handle gypsum panels in a manner to prevent mold growth on panels.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until building is dried in and installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 ASSEMBLY MATERIALS

A. General: Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.

1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

B. Steel Framing: ASTM C 645, of profile, size, and base metal thickness required to produce assemblies complying with structural performance requirements, with sectional properties computed in conformance with AISI "Specification for Design of Cold-Formed Steel Structural Members".

1. Protective Coating: ASTM A 653, G60, hot-dip galvanized coating.

C. Gypsum Liner Panels: ASTM C 442, Type X liner panel or coreboard designed for shaft wall construction in 1-inch thickness and with moisture-resistant paper faces.

D. Gypsum Wallboard: ASTM C 36, Type X and as follows:

1. Edges: Tapered and featured (rounded or beveled) for prefilling.

E. Mold Resistant Gypsum Board: Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M.; with fiberglass mat laminated to both sides. Specifically designed for interior use.

1. Core: 5/8 inch abuse resistant.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

F. Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 09 Section "Gypsum Board Assemblies" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.

G. Gypsum Wallboard Joint-Treatment Materials: ASTM C 475 and as specified in Division 09 Section "Gypsum Board Assemblies."

H. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112-inch thick.

I. Track (Runner) Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Powder-Actuated Fasteners: Provide powder-actuated fasteners with capability to sustain, without failure, a load equal to 10 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 1190.
2. Postinstalled Expansion Anchors: Where indicated, provide expansion anchors with capability to sustain, without failure, a load equal to 5 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.

J. Acoustical Sealant: As specified in Division 09 Section "Gypsum Board Assemblies."

K. Sound Attenuation Blankets: ASTM C 665 for Type I, unfaced mineral-fiber-blanket insulation produced by combining thermosetting resins with mineral fibers manufactured from slag or rock wool.

L. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum boards of type indicated.

1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

M. Spot Grout: ASTM C475, setting-type joint compound of type recommended for spot grouting hollow metal door frames.

2.2 GYPSUM BOARD SHAFT WALL

A. General: Characteristics of selected components are described below for purposes of indicating gypsum board shaft wall systems which are manufacturers' standard assemblies. Provide complete shaft wall systems which comply with requirements indicated.

B. Studs: Manufacturer's standard profile for repetitive members and corner and end members and for fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base Metal Thickness: As required to comply with structural performance requirements.

a. Framing for Water-Resistant, Gypsum Backing Board: Provide minimum base-metal thickness of 0.0312-inch for steel studs framing for tile backing panels.

C. Track (Runner): Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2-inches long, in depth matching studs.

1. Minimum Base Metal Thickness: As required to comply with structural performance requirements.

a. Framing for Water-Resistant, Gypsum Backing Board: Provide minimum base-metal thickness of 0.0312-inch for steel runners framing for tile backing panels.

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products:

a. Blazeframe; Composite Profiles.
b. Dietrich Metal Framing; The System by Metal-Lite, Inc.
c. Fire Trak Corp.; Fire Trak.

E. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches, in depth matching studs, and not less than 0.0341 inch thick.

F. Cavity Insulation: Sound attenuation blankets.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft-wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:

1. ASTM C 754 for installing steel framing.
2. Division 09 Section "Gypsum Board Assemblies" for applying and finishing panels and installing trim accessories.

B. Do not bridge building expansion joints with shaft-wall assemblies; frame both sides of joints with furring and other support.

C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.

1. At elevator hoistway door frames, provide jamb struts on each side of door frame, size and gauge as recommended by the wallboard manufacturer.
2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 face-layer panel.

D. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.

E. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

F. Isolate gypsum finish panels from building structure to prevent loading to shaft wall system, both vertically and horizontally, and to prevent cracking of finish panels while maintaining continuity of fire-rated construction. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Comply with details shown and with manufacturer’s instructions.

G. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

H. Control Joints: Install control joints at locations indicated on Drawings, and where not indicated, according to ASTM C 840 and the following in specific locations approved by Architect for visual effect, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.

1. A control joint shall be installed where a partition or wall traverses a construction joint (expansion, or building control element) in the base building structure.
2. Control joints shall be installed where a wall or partition runs in an uninterrupted straight plan exceeding 30 linear feet.
3. A control joint shall be installed where a partition or wall abuts a dissimilar wall or ceiling, or penetration.
4. A control joint shall be installed where partition or wall changes within plane of partition or wall.
5. Less-than-ceiling height door and window frames shall have control joints extending from both frame corners to the ceiling or shall have additional framing reinforcement at the frame corners to distribute concentrated stresses.

I. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.

J. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 2 inches of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2 or 5/8-inch thick, gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft-wall framing.
2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to the shaft-wall framing.

3.3 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to Installer, which ensures gypsum board shaft wall system construction being without damage or deterioration at time of Substantial Completion.

1. Provide protection and maintain conditions in a manner to prevent mold growth on gypsum panels. If mold growth occurs, replace gypsum panels; surface treatment of gypsum panels for mold removal is not permitted.

END OF SECTION 092123

SECTION 093000 – TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Tile Types
   a. TL01 - Porcelain Floor Tile
   b. TL02 – Porcelain Wall Tile
   c. TL03 – Large Format ultra-thin porcelain wall tile.
   d. TL04 – Porcelain floor tile.
2. Stone thresholds installed as part of tile installations.
3. Metal edge strips installed as part of tile installations
   a. Metal Trim installation detail execution requirements.
4. Waterproofing and crack isolation membranes for thin-set tile installations membrane.
5. Tile backing panels.
6. Tile Schedule – Part 3.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Division 09 “Gypsum Board Assemblies” for non-Structural metal framing supporting tile backer boards and backing boards.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

E. Large Format Tile (LFT): greater than 16 inches in any dimension.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Dynamic Coefficient of Friction of Tile for Floors: For tile installed on walkway surfaces, provide products with the following values determined by testing identical products using the BOT-3000 to measure slip resistance of flooring, and the minimum requirement for floor surfaces in wet or dry conditions shall be:

1. 0.42 for floors and stair treads.
2. 0.51 minimum for ramp surfaces.

B. Installation shall conform to the requirements of the 2017 Edition of Tile Council of North America Handbook procedures for installation of Large Format Tile including, but not limited to, preparation of the substrate.

C. For Walls supporting large format wall tiles, use a minimum 3-5/8 inch thick 20 gage (33 mils structural quality) studs spaced 16 inches on center and braced 4 ft. O.C. vertically.

1. TCNA requires support for fully adhered tiling systems to have a maximum deflection of L/720.
2. Steel Stud Manufacturer's Association (SSMA) charts for limiting height and deflection, require use of axially and transverse loaded heavy gage Cold Formed Metal Framing systems (not regular non-structural metal studs) for deflections more severe than L/360.

D. Concrete slabs receiving large format tiles must have a minimum ICRI concrete surface profile (CSP) of 3. For more detailed ICRI CSP information refer to ICRI Guideline No. 03732.

E. Maximum allowable variation in the tile substrate: 1/8-inch in 10 ft from the required plane when measured from the high points in the surface.

1.5 SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory for each color and finish required.
4. Stone thresholds in 6-inch lengths.

1.6 INFORMATION SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

E. Slip Resistance Test Reports: Submit test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile products with requirements specified for slip resistance.

F. Maintenance Data: For porcelain tile and thresholds to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.7 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

1. Stone thresholds.
2. Waterproof membrane.
3. Crack isolation membrane.
4. Joint sealants.

D. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Wall mock-up shall be 10 ft x 10 ft area with trim and/or transition pieces.
2. Approval of mockups before grouting (Dry-Lay Mockups): Approval of mockups before grouting is for tile pattern; layout; coursing; and aesthetic qualities of workmanship.
   a. Do not grout joints until dry-lay mockups are approved by Design Builder.
3. Approval of mockups after grouting: Approval of mockups after grouting is for tile pattern; layout; coursing; expansion joint locations; relationship of grout and sealant colors to tile colors; tooling of joints; and aesthetic qualities of workmanship.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish quantity of full-size units equal to 1 percent of amount installed, for each type, composition, color, pattern, and size indicated.

1. Leave unused boxes of tile for Owner replacement stock.

1.11 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Total System Warranty: Provide total system warranty in which setting material's manufacturer agrees to repair or replace components of ceramic tile system that do not comply with requirements, that fail in material or workmanship, that fail to remain watertight, or that exhibit cracking or other defects within specified warranty period.

1. Warranty repair shall include all repairs necessary to correct cracks or leaks, including the cost of materials and labor required to make the repairs. Warranty shall include removal and subsequent replacement of all tile and other finish materials and accessories covering the setting materials, including the cost of materials and labor.

2. Warranty Period: Fifteen (15) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation in swimming pools, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. Manufacturers: Acceptable manufacturers include the following or equal. Basis of Design manufacturers and products are indicated in the Finish Legend on the drawings. Refer to tile types legend in Part 1.2 Summary.

1. Atlas Concorde
2. Ceramic Technics
3. Consentino Dekton
4. (Basis of Design) Crossville
5. Daltile
6. (Basis of Design) Fiandre
7. Nautilus
8. Stonepeak

B. TL01 and TL04 - Large Format Porcelain Floor Tile.

1. Basis of Design Manufacturer, Product name, model number, color: see Interior Finish Schedule.
2. Type: large format porcelain.
3. Module size: See Finish Schedule.

4. Grout width: as recommended by manufacturer.
5. Grout Color: As selected by Design Professional.
6. Locations: as indicated.

C. TL02 - Porcelain Wall Tile

1. Basis of Design Manufacturer, Product name, model number, color and module size: see Finish Legend.
2. Composition: Porcelain
3. Finish: As Indicated on legend
4. Tile thickness: As Indicated on legend
5. Recommended grout width: As Indicated on legend
6. Color and Pattern: As indicated on the Finish Legend.

D. TL03 - Large Format Ultra-Thin Porcelain Wall Tile.

1. Basis of Design Manufacturer, Product name, model number, color: see Interior Finish Schedule.
2. Type: large format ultra-thin porcelain.
3. Module size: See Finish Schedule.
4. Grout width: as recommended by manufacturer.
5. Grout Color: As selected by Design Professional.
6. Locations: as indicated.

2.3 METAL TRIM

A. Metal Edge Strips: Square-shapes, height to match tile and setting-bed thickness, metallic, designed specifically for wall applications, stainless steel; ASTM A 666, 300 Series, exposed-edge material with perforated flanges. Provide accessories required for a complete installation, including inside and outside corners, connectors, and end caps.

B. Metal Trim Manufacturers providing products in compliance with requirements include the following or equal:

1. Blanke
2. Powerhold
3. (Basis of Design) Schluter Systems.
4. (Basis of Design) Tarkett

C. Products: Refer to drawing details

1. External Corner Protector: Schluter-JOLLY; Schluter Systems or equal.
2. Edge Trim (Square): Schluter-JOLLY; Schluter Systems or equal.
3. Edge Trim: Schluter SCHIENE
4. Metal cove: (Basis of Design) Schluter-JOLLY; Schluter Systems Dilex-EHK or equal.

2.4 TILE BACKING PANELS

A. Refer to Division 09 “Gypsum Board Assemblies” for products and installation.

2.5 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.

B. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 per ASTM C 1353 or ASTM C 241 and with honed finish.

1. Description: As selected by Architect.

2.6 WATERPROOFING MEMBRANE

A. NOTE: Provide manufacturer’s recommended sealer at gypsum cement underlayment before installing waterproofing membrane.

B. General: Manufacturer's standard product, selected from the following complying with ANSI A118.12 for standard performance and recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

C. Self-curing liquid rubber polymer and a reinforcing fabric applied to form a flexible, seamless waterproofing membrane that bonds to a wide variety of substrates.

D. Acceptable Manufacturers include the following or equal:

1. Custom Building Products
2. Laticrete International, Inc.
3. MAPEI

E. Provide Waterproofing Membrane.

1. Custom; Custom RedGard
2. LATICRETE, "Laticrete Hydro Ban”
3. MAPEI; Mapelastic HPG

F. Thin (dries to 0.5 mm) load-bearing waterproofing membrane.

2.7 CRACK ISOLATION MEMBRANES

A. NOTE: Provide 100% full coverage crack isolation membrane except at areas to receive waterproofing.

B. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

C. Acceptable Manufacturers include the following or equal:

1. Custom Building Products

2. Laticrete International, Inc.
3. MAPAEI

D. Products and Manufacturers”

1. Peel and Stick: High performance, pliable, light weight peel and stick membrane designed for use under thin-bed adhesives for ceramic tile, stone and other hard surface installations
   a. (Basis of Design) Laticrete International. Inc.; Laticrete Fracture Ban and Primer or equal.

2. Single component, reinforced with Kevlar, and tested to ASTM E2179 and ASTM E492 for impact sound isolation.
   a. (Alternate) Trowelable: Laticrete International. Inc.; “125 Crack and Sound Adhesive” or equal.

2.8 SETTING MATERIALS

A. Acceptable Manufacturers include the following or equal:

1. Custom Building Products
2. Laticrete International, Inc.
3. MAPAEI

B. Glass tile Installation: Multipurpose Glass Adhesive Mortar: one-step, non-sag, polymer fortified adhesive mortar that is specifically formulated for use in glass tile applications complying with ANSI A118.4 .

1. (Basis of Design) Custom; “Glass Tile Premium Thin-Set Mortar.”
2. Laticrete Glass Tile Adhesive
3. MAPEI, “Adesilex P-10”

C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

1. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.

   a. Custom; “VersaBond Flex”
   b. Laticrete; “Laticrete 4XLT”
   c. MAPEI; “Ultraflex LFT/Ultralight”

D. Self-leveling polymer modified Portland cement, bonding primers, and LHT tile setting system floors for <u>large format tile</u>:

1. (Basis of Design) Laticrete or equal.
   a. Self-Leveling Polymer Modified Portland Cement: "NXT level plus"
   b. Primer: NXT Primer.
   c. LHT Setting System: "4XLT"

E. Latex-Portland Thick Bed Cement Mortar Bed: Latex additive (water emulsion), serving as replacement for any gauging water, combined at job site with prepackaged dry mortar mix supplied or specified by latex additive manufacturer.

1. Available Manufacturers and Products or equal:

a. Custom; Thick Bed Mortar.
b. (Basis of Design) Laticrete 3701 Mortar Admix and Laticrete 226 Thick Bed Mortar.
c. MAPEI; Modified Mortar Bed.

2.9 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3 typical at all areas except kitchen.

1. Acceptable Products include the following or equal:
a. Custom Building Products; CEG-lite
b. Laticrete International, Inc; SpectraLOCK
c. (Basis of Design) MAPAEI; Kerapoxy

B. Product: Water-Cleanable Epoxy Grout: ANSI A118.5 at kitchen. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, and certified by manufacturer for intended use.

1. Product: (Basis of Design) Laticrete International, Inc.; Laticrete SpectraLOCK 2000 IG Grout or equal.

2. Product Characteristics:
a. Industrial Grade
b. High Chemical Resistance.
c. Anti-microbial.

C. Latex-Portland Cement Grout: ANSI A118.6, color as selected by Architect.

1. Polymer Type: Styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix serving as replacement of gauging water.
2. Unsanded grout mixture for joints 1/8 inch and narrower.
3. Sanded grout mixture for joints 1/8 inch and wider.

D. Polymer Modified Unsanded Grout:

1. Custom: Prism/Polyblend
2. Laticrete: 1600 Unsanded Grout
3. MAPEI: Keracolor U

E. Sanded Grout: Provide one of the following or equal:

1. Custom; Prism
2. Laticrete; Permacolor
3. MAPEI; Ultracolor Plus.

F. Grout for Pre-grouted Tile Sheets: Same product used in factory to pre-grout tile sheets.

2.10 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."

1. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.

   a. Custom; Commercial 100% Silicone Caulk.
   b. Laticrete “Latasil 100% silicone”
   c. MAPEI; Mapesil.

2. Or equal by selected manufacturer or as listed in Division 07 “Joint Sealants.”

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated or as selected by Design Professional on approved shop drawings..

2.11 MISCELLANEOUS MATERIALS

A. Trowelable Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated. See Part 3 Preparation.

1. Acceptable Manufacturers include the following or equal:
   a. Custom Building Products
   b. Laticrete International, Inc.
   c. MAPAEI

2. (Basis of Design) Laticrete NXT Skim and Laticrete NXT Patch or equal.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming stone tile and grout surfaces, specifically approved for materials and installations indicated by stone tile producers and grout manufacturers.

1. Acceptable Manufacturers include the following or equal:
   a. Custom Building Products
   b. Laticrete International, Inc.
   c. MAPAEI

2. (Basis of Design) Laticrete StoneTech Klenzall Cleaner or equal.

2.12 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with adhesives comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Design Builder.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CONCRETE SLAB PREPARATION

A. New concrete slabs must be allowed to cure for a minimum of 28 days and have a minimum CSP of 3 prior to installing self-leveling products.

1. Refer to ACI 302.2R-06 “Guide for Concrete Slabs that Receive Moisture Sensitive Flooring.

2. All curing compounds (including “self-dissipating” curing compounds) must be removed by shot blasting, scarifying or other mechanical means to a minimum CSP of 3 per ICRI Guideline No. 03732 then swept and vacuumed clean.

3. New concrete slabs that have been power troweled, burnished or over troweled must be shot blast, scarified or prepared by other mechanical means to a minimum CSP of 3 then swept and vacuumed clean.

B. Moisture:

1. Concrete slabs must be tested and measure less than 95% relative humidity (RH) per ASTM F2170 prior to installation of self-leveling products.

2. Apply manufacturer-approved moisture mitigation system according to manufacturer’s written instructions. Refer to Division 09 “Water Vapor Emission Control Systems” for additional requirements.

3. Do not install self-leveling products when there is standing water or visible moisture on the surface.

C. Preparation of concrete substrate for self-leveling:

1. Self-leveling installer shall ensure that the substrate is properly prepared and primed prior to installation.

2. Fill cracks, holes, and depressions in concrete substrates for porcelain tile floors installed with thinset mortar with trowelable patching compound specifically recommended by tile-setting material manufacturer.

3.4 INSTALLATION TILE BACKING PANELS

A. Tile Backing Panels: Install panels and treat joints according to ASTM C840, manufacturer's written instructions for type of application indicated and TCNA Handbook for Ceramic Tile Installation.

1. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 GENERAL TILE INSTALLATION

A. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

B. Comply with 2015 TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods for large format tiles specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

   a. Large format ceramic tile.

C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in pattern indicated on drawings. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

   1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: as recommended by manufacturer.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion and Control Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated or as directed by manufacturers instructions. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

   1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).
   2. Do not extend cleavage membrane under thresholds set in dry-set portland cement mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane with elastomeric sealant.

3.6 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.7 WATERPROOFING MEMBRANE INSTALLATION

A. Install waterproofing membrane to comply manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproofing membrane until membrane has cured.

3.8 METAL TRIM INSTALLATION

A. Follow manufacturer's written metal trim installation instructions for all metal trim installation including walls and floor as follows:

1. Select metal trim according to tile thickness and as indicated on drawings.
2. Apply thin-set mortar using notched trowel, to area where profile is to be placed. If metal trim is to be used as edging for outside wall corners, finish tiling one wall first; then trowel thin-set mortar over the corner area of the second wall.
3. Press perforated anchoring leg of profile into mortar and align.
4. Trowel additional thin-set mortar over perforated anchoring leg to ensure full coverage and support of tile edges.
5. Solidly embed tiles so that tiled surface is flush with top of profile; profile should not be higher than the tiled surface and should be approximately 1/32-inch lower.
6. Set the tile to integrated joint spacer, ensuring a uniform joint of 1/16 - 1/8-inch according to match adjacent joint widths.
7. Fill the joint completely with grout or setting material.
8. Work with materials and tools that will not scratch or damage sensitive surfaces. Setting materials and grouts must be removed immediately, especially from anodized aluminum surfaces.

3.9 INSTALLATION TOLERANCES

A. Variation in Level: For horizontal joints and other conspicuous lines, do not exceed 1/8 inch in 10 ft.

B. Variation in Surface Plane of Flooring: Do not exceed 1/8 inch in 10 ft. from level or slope indicated when tested with a 10-ft. straightedge.

C. Variation in Plane between Adjacent Units (Lipping): Do not exceed requirements as defined in ANSI A108.02 4.3.7.

3.10 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove epoxy grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.11 INTERIOR TILE INSTALLATION SCHEDULE:

A. Wall tile on non-wet walls : **TCNA W245**; thinset mortar on glass-mat, water-resistant gypsum backer board.

1. Ceramic Tile.
2. Thinset Mortar: polymer-fortified adhesive mortar ANSI A118.15.
3. Grout: Water-cleanable epoxy grout. ANSI A118.3

B. Large format floor tile: **TCNA F125-Full**; thinset mortar on crack isolation membrane.

1. Ceramic Tile Type: ceramic.
2. Crack Isolation Membrane ANSI A118.12, ANSI A118.13, ASTM C627
3. Thinset Mortar: polymer-fortified adhesive mortar ANSI A118.15.
4. Grout: Water-cleanable epoxy grout. ANSI A118.3

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Acoustical panels and exposed suspension systems for ceilings.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

B. Related Sections:

1. Division 01 "Alternates" for alternates for ceilings.
2. Division 09 “Gypsum Board Assemblies” for gypsum board ceilings.

1.3 DEFINITIONS

A. AC: Articulation Class.

B. CAC: Ceiling Attenuation Class.

C. LR: Light Reflectance coefficient.

D. NRC: Noise Reduction Coefficient.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members.
2. Method of attaching hangers to building structure.

a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
4. Minimum Drawing Scale: 1/8 inch = 1 foot.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- long Samples of each type, finish, and color.

1.6 INFORMATION SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

B. Maintenance Data: For finishes to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.

C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.

b. Identify materials with appropriate markings of applicable testing and inspecting agency.

2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:

a. Smoke-Developed Index: 450 or less.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.10 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to 3.0 percent of quantity installed.
2. Suspension System Components: Quantity of each exposed component equal to 3.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CEILING UNITS - GENERAL:

A. Standard for Acoustical Ceiling Units: Provide units conforming to applicable requirements of ASTM E 1264 for Class A materials.

B. Manufacturers: Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:

2.2 CEILING TYPES: REFER TO REFLECTED CEILING PLANS

A. Manufacturers providing products in compliance with requirements include the following or equal:

1. Armstrong World Industries, Inc.
2. USG Interiors
3. (Basis of Design) Rockfon

B. **AC01**: Refer to Division 09 “Gypsum Board Assemblies.”

C. **AC02**: Refer to Division 09 “Acoustical Plaster System.”

D. **AC03:** Tegular, NRC >=.75, Light Reflectance <=.80; BOD: Rockfon Artic, SLN or equal.

1. ASTM E1264 Classification: Type XX, Pattern G.
2. Edges: SLN.
3. Size: 24 by 24 inches.
4. Thickness: [5/8 inch] [3/4 inch].
5. NRC: 0.75.
6. CAC: 23.
7. Fire Class: Class A.
8. Fire Performance UL 723 (ASTM E 84) Flame Spread / Smoke Developed: 0/5.
9. Fire Performance CAN ULC S102 Flame Spread / Smoke Developed: 5/0.
10. Light Reflectance: 0.85.
11. Recycled Content: Up to 37 percent.
12. R Value (BTU Units): [2.2] [2.6].
13. RSI Value (Watts Units): [0.39] [0.46].

E. **AC04:** Tegular, NRC >= .90, Light Reflectance <= .80; BOD: Rockfon Alaska, SLN or equal. ASTM E1264 Classification: Type XX, Pattern G.

1. Edges: SLN
2. Size: 24 by 24 inches.
3. Thickness: [3/4 inch] [7/8 inch]
4. NRC: 0.90.
5. CAC: 22.
6. AC: 180.
7. Fire Class: Class A.
8. Fire Performance UL 723 (ASTM E 84) Flame Spread / Smoke Developed: 0/5.
9. Fire Performance CAN ULC S102 Flame Spread / Smoke Developed: 5/0.
10. Light Reflectance: 0.86.
11. Recycled Content: Up to 39 percent.
12. R Value (BTU Units): [2.6] [3.1].
13. RSI Value (Watts Units): [0.46] [0.54].

F. **AC05:**

1. Refer to Division 09 “Metal Ceiling Assemblies."
2. Refer to Division 01 "Alternates" for alternates for this ceiling type.

G. **AC06:** (Not Used)

H. **AC07:** Wet Formed Mineral Fiber with Vinyl-Faced Membrane, (Basis of Design) USG Mars Healthcare Clean Room Panels, 86169CR.

1. Classification: Provide panels complying with ASTM E 1264 for Type IV, mineral base; Form 2, Pattern E.
2. Physical Properties:
   a. Dimensions: 24" x 24" x 3/4"
   b. Overlay: Soil-resistant vinyl-faced membrane overlay on face and vertical edges.
   c. Color: White.
   d. NRC; 75
   e. CAC: Not less than 35.
   f. LR: Not less than 0.90.
   g. Edge Detail: Square.
   h. Antimicrobial Treatment: Coating based.
   i. Locations: Autoclave and as indicated.

2.3 CEILING SUSPENSION SYSTEMS - GENERAL:

A. Manufacturer: Provide suspension systems from the same manufacturer as the Acoustical Panels. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:

1. Armstrong World Industries, Inc.
2. USG Ceilings Plus
3. (Basis of Design) Rockfon
4. Or equal.

B. Provide suspension systems conforming to specified requirements and to requirements of ASTM C 635.

C. Colors for Exposed Suspension Elements and Accessories with Painted Finish:
1. Architect to choose from Manufacturer’s standard colors.

D. Finishes: Manufacturer's standard shop-applied finishes.

E. Attachment Devices for Suspension System:

1. Anchors and intermediate support members: Provide sizes capable of sustaining 5 times the load-carrying capabilities shown in ASTM C 635, Table 1, "Direct Hung" column.
2. Deck inserts and hanger clips: Fabricate from hot-dip galvanized steel.
3. Hanger wire: Zinc-coated (galvanized) carbon steel wire, ASTM A 641, soft temper, with Class 1 coating, minimum 12 gage (0.105 inch diameter).

F. Edge Moldings and Trim:

1. (Basis of Design) Rockfon Metal: Infinity CDX Square Profile
2. Extruded plastic or metal; provide profiles indicated.
3. Circular ceiling penetrations: Provide edge moldings which precisely fit penetrations.

G. Suspension System: Manufacturer’s standard for the type of ceiling panels specified. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch-(24-mm-) wide metal caps on flanges.

1. Structural Classification: Intermediate -duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Aluminum.
5. Coordinate finish with metal type selected.
6. Cap Finish: Painted white

2.4 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.5 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM

E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Postinstalled expansion anchors.
b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636 per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
2. Anchor Ceiling System to structure only. No ties made to ductwork, old ceilings, conduit, or other non-structural components will be allowed.
3. Acoustical ceiling tile shall not be installed until all work above ceilings has been completed and temperature and humidity will be maintained as indicated for final occupancy.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counters-playing, or other equally effective means.
3. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
6. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
7. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

8. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
9. Power-Actuated fasteners shall not be used in the following applications:

   a. Exterior soffits
10. Do not attach hangers to steel deck tabs.
11. Do not attach hangers to steel roof deck. Attach hangers to structural members.
12. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
13. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:
   a. As indicated on reflected ceiling plans.
   b. Install panels with pattern running in one direction parallel to long axis of space.
   c. Install panels in a basket-weave pattern.
2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Resilient base.
2. Resilient molding accessories.
3. Resilient stair accessories.

B. Related Sections:

1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 09 Section "Resilient Sheet Flooring".
3. Division 09 Section "Resilient Tile Flooring".
4. Division 09 "Tile Carpeting".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of product indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.5 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F , in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F .

C. Install resilient products after other finishing operations, including painting, have been completed.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 WB01: RESILIENT BASE

A. Resilient Base: See Finish plans and legend for location and type.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
      b. Johnsonite.
      c. Roppe Corporation, USA.

B. Resilient Base Standard: ASTM F 1861.

   1. Material Requirement: Rubber.
   2. Manufacturing Method: Group I (solid, homogeneous).
   3. Style: Cove base.
   4. Minimum Thickness: 0.125 inches.
   5. Height: 4 inches, see finish plans and legend for location and type.
   6. Lengths: Use maximum lengths to minimize cuts.
   7. Outside Corners: Manufactured (pre-formed).
   8. Inside Corners: Manufactured (pre-formed).
   9. Finish: Satin.
   10. Colors: To be selected by Architect from manufacturer’s standard.

2.2 RESILIENT MOLDING ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
   2. Johnsonite.
   3. Roppe Corporation, USA.

B. Description: as indicated for transitions.

C. Material: Rubber.

D. Profile and Dimensions: As indicated.

E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Cove Base Adhesives: Not more than 50 g/L.
   b. Rubber Floor Adhesives: Not more than 60 g/L.

C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products until Substantial Completion.

END OF SECTION 096513

SECTION 096500 -- RESILIENT FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Resilient Tile flooring locations as indicated on drawings.
2. Types include:

   a. RF01: Luxury Vinyl Tile
   b. RF04: Rubber Sheet Flooring
   c. RF05: Vinyl tile with quartz aggregates.

B. Related Sections:

1. Division 01 Section “Sustainable Design Requirements.”
2. Division 09 Section "Resilient Base and Accessories" for accessories installed with resilient floor coverings.
3. Division 09 “Static-Control Resilient Flooring” static dissipative sheet flooring.
4. Division 09 Section “Water Vapor Emission Control Systems.”

1.3 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Slip Resistance: Meet or exceed ADA and ASTM D2047 – 17: Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces.

1. Static coefficient of friction of not less than 0.5, as measured by this test method.

C. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore certification.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.

1.5 INFORMATION SUBMITTALS

A. Product Schedule: For floor tile. Use same designations indicated on Drawings.

B. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

C. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

C. Mock-ups: Install at project site a job mock-up using acceptable products and manufacturer approved installation methods, including concrete substrate testing. Obtain Owner’s and Consultant’s acceptance of finish color, texture and pattern, and workmanship standards.

1. Mock-up Size: 10’ x 10’ or as indicated by Design Professional.
2. Maintenance: Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
3. Incorporation: Mock-up may be incorporated into final construction upon Owner’s approval.

D. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer’s installation instructions and manufacturer’s warranty requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.8 SEQUENCING AND SCHEDULING

A. Finishing Operations: Install flooring after finishing operations, including painting and ceiling operations, have been completed.

B. Concrete Curing: Do not install flooring over concrete substrates until substrates have cured and are dry to bond with adhesive as determined by resilient flooring manufacturer's recommended bond testing, moisture testing, and pH testing.

1.9 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70-deg F or more than 95-deg F, in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55-deg F or more than 95-deg F.

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

1.10 EXTRA MATERIALS (ATTIC STOCK)

A. To be decided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Quality: Obtain resilient flooring product materials from a single manufacturer.

2.2 RF01 - RESILIENT LUXURY VINYL TILE

A. Description: Luxury Vinyl Tiles are comprised of a vinyl wear layer with a high performance topcoat and thick glass interlayer with a thick solid backing. Class/ASTM F1700: Class III Printed Vinyl Tile.

B. Manufacturers and Products include the following:

1. (Basis of Design) Interface; “Drawn Lines.”
2. Polyflor; “Expona Commercial.”
3. Six Degrees; “Compass.”

C. Product and Performance Properties:

1. Wear Layer Thickness 22 mil
2. Total Thickness 4.5 mm
3. Backing Class Commercial Grade
4. Finish Ceramor
5. Nominal Dimensions 9.845 in x 39.38 in
6. IIC Sound Rating (ASTM E492-09) 57 IIC
7. Slip Resistance (ASTM D2047) >0.55 wet/dry, ADA Compliant
8. Static Load Limit (ASTM F970) 1500 psi
9. Flexibility (ASTM F137) Passes
10. Resistance to Heat (ASTM F1514) Passes
11. Resistance to Light (ASTM F1515) Passes
12. Radiant Flux (ASTM E648) Class I
13. Smoke Density (ASTM E 662) ≤ 450
14. Size & Squareness (ASTM F2055) Passes, +/- 0.016 in. per linear foot
15. Thickness (ASTM F386) Passes
16. Dimensional Stability (ASTM F2199) Passes
17. Residual Indentation (ASTM F1914) Passes
18. Resistance to Chemicals (ASTM F925) Passes
19. Environmental Specifications
20. Indoor Air Quality FloorScore®/CDPH 01350 Certified for Low-VOC emissions
21. Material Composition Free of Ortho Phthalates, Added Formaldehyde and Heavy Metal Stabilizers
22. Pattern and Color: as indicated on Finish Schedule.
23. Adhesive: manufacturer's recommended.

2.3 RF03: RESILIENT RUBBER FLOORING

A. ASTM F1344 Standard Specification for Rubber Floor Tile: Type I and Grade 1. Resilient tile composition includes vulcanized rubber compound 913 with environmentally compatible color pigments that are free of toxic heavy metals like lead, cadmium or mercury

B. Manufacturers and Products include the following:

1. (Basis of Design) Nora; "Signa/Environcare"
2. Polyflor; "Palletone PUR."
3. Flexco "Creative Elements."

C. Rubber Floor Tile: Product Characteristics:

1. Composition: Homogeneous rubber compound with a random scattered design.
2. Surface: Smooth.
3. Back of Tile: Double-sanded smooth.
4. Thickness (ASTM F386):0.08 inches (2mm).
5. Flammability (E648/NFPA 253): Class 1.
6. Smoke Density (ASTM E662/NFPA 258): < 450 i
7. Burn Resistance: Resistant to cigarette and solder burns
8. Slip Resistance (ASTM D2047): ≥ 0.5 Static coefficient of friction,
9. Bacteria Resistance (ASTM E2180/ASTM G21): Resistant to bacteria, fungi, and micro-organism activity
10. VOC's: GREENGUARD Gold Certified for Low VOC Emissions
11. Hardness (ASTM D2240): ≥ 85 is required; Shore type "A", 92

12. Static Load (ASTM F970): ≤ 0.005 inches with 250 lbs. is required Residual compression of 0.003 inches with 800 lbs.
13. Rolling Load Limit: ≤ 450 lbs. / sq. inch, with no forklift traffic.
14. Abrasion Resistance (ASTM D3389): ≤ 0.035 oz. (1.0g) is required 1.1 lbs. (500g) load on H-18 wheel with 1000 cycles, 0.008 oz. (0.24g) weight loss
15. Elongation (ASTM D412): ≥ 300 lbs. per sq. inch is required Modulus @ 10% is 913.1 lbs. per sq. inch
16. Oil & Grease Resistance: No
17. Heat Resistance (ASTM F1514): Avg. ∆E ≤ 8.0 is required.
18. Light Resistance: Avg. ∆E ≤ 8.0 is required.
19. Static Generation (AATCC 134): < 2000 Volts at 20% RH
20. Thermal Transmission (ASTM C518): R-value of 0.04
21. Limited Wear Warranty: 5 years.

2.4 RF05: RESILIENT FLOORING – QUARTZ VINYL TILES

A. ASTM F1066 Standard Specification for Vinyl Composition Floor Tile.

B. Manufacturers and Products include the following:

1. (Basis of Design) UpoFloor; “QuartzTile”
2. Procedo; Versa Quartz Tile.”
3. Rikett; “Quartz Tile.”

C. Quartz Tile: Product Characteristics:

1. Product Standard: Tested in accordance with ASTM F1066 for minimum product standards.
2. Fire Resistance: Flammability exceed minimum for Class 1 rating per ASTM E648.
3. Smoke Density: Less than 450 when tested in accordance with ASTM E662.
4. Chemical Resistance: UPOFLOOR Quartz Tile is virtually unaffected by surface water and most chemicals which do not have a solvent action on vinyl. Certain chemicals can cause staining, and acids and dyes can affect the color, which should be selected accordingly.
5. Flexibility: UPOFLOOR Quartz Tile meet flexibility requirements of ASTM F1066.
6. Indentation Resistance: Meets indentation resistance requirements of ASTM F1066.
7. Slip Resistance: Meets and exceeds current published slip resistance requirements of OSHA. Tests were performed in accordance with ASTM D2047 for dry conditions.
8. Static Load Limit: Tested to 3500 psi in accordance with ASTM F970.
9. Light Resistance: Meets light resistance requirements of ASTM F1066.
10. Color: Refer to Finish Legend.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

C. Floor Polish: Provide protective liquid floor polish products only as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.

B. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

C. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.

    a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3-lb of water/1000-sq. ft. in 24 hours.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

E. Do not install floor tiles until they are same temperature as space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis, unless otherwise indicated.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles. Lay tiles with grain running in one direction, unless otherwise indicated.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.

B. Perform the following operations immediately after completing floor tile installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.

1. Apply only according to manufacturer’s written instructions.

E. Cover floor tile until Final Completion.

END OF SECTION 096500

SECTION 096536 - STATIC-CONTROL RESILIENT FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Static-dissipative resilient flooring.
   a. RF02: PVC Static-dissipative sheet flooring
   b. RF03: Static-dissipative rubber sheet flooring.

B. Related Sections:

1. Division 01 Section “Sustainable Design Requirements.”
2. Division 09 Section “Resilient Base and Accessories.”
3. Division 09 Section “Resilient Flooring.”
4. Division 09 Section “Water Vapor Emission Control Systems.”

1.3 PERFORMANCE REQUIREMENTS

A. Static-Dissipative Properties: Provide floor coverings with static-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

1. Electrical Resistance: Test per ASTM F 150 with 100-V applied voltage

   a. Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.
   b. Average no less than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.

2. Static Generation: Less than 10 V when tested per AATCC-134 at 40 percent relative humidity with conductive footwear.
3. Static Decay: 5000 to 0 V in less than 0.5 seconds when tested per FED-STD-101C/4046.1.

B. Slip Resistance: Meet or exceed ADA and ASTM D2047 – 17: Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces.

1. Static coefficient of friction of not less than 0.5, as measured by this test method.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each type of floor covering. Include floor covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

A. Samples for Verification: In manufacturer's standard size, but not less than 12-by-12-inch sections of each different color and pattern of floor covering required. Include base coves, cap strips, joint cover strips.

1. For heat-welding bead, manufacturer's standard-size samples, but not less than 12-inches long, of each color required.

B. Heat-Welded Seam Samples: For each flooring product and welding bead color and pattern combination required; with seam running lengthwise and in center of 6-by-9-inch sample applied to a rigid backing and prepared by Installer for this Project.

C. Field Samples:

1. Corner construction: Have each installer who will be installing integral base produce field samples of inside and outside corners including joint with flooring. Minimum size 16 inches square.

1.5 INFORMATION SUBMITTALS

A. Qualification Data: For installers and factory custom-cutting service suppliers.

B. Sample Warranty.

C. Floor Moisture Emissions Report: Include floor plans for each location to receive resilient sheet flooring showing test locations and emission rates.

1. If report indicates that moisture control remediation is required, submit plans and description of procedures.

D. Maintenance Data: For each type of floor covering to include in maintenance manuals.

E. Provide certification of ADA slip resistance compliance for all working surfaces along with test data from an independent testing laboratory in accordance with ASTM C 1028. Test shall be performed on the completed installed floor surface AFTER the final finish is applied.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

C. Mock-ups: Install at project site a job mock-up using acceptable products and manufacturer approved installation methods, including concrete substrate testing. Obtain Owner's and Consultant's acceptance of finish color, texture and pattern, and workmanship standards.

1. Mock-up Size: 10' x 10' or as indicated by Design Professional.
2. Maintenance: Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
3. Incorporation: Mock-up may be incorporated into final construction upon Owner's approval.

D. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

1.7 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor coverings.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install floor coverings after other finishing operations, including painting, have been completed.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish not less than one box for each fifty (50) boxes or fraction thereof, of each class, wearing surface, color, pattern, and size of resilient floor installed..

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Quality: Obtain resilient flooring product materials from a single manufacturer.

2.2 RF02: STATIC DISSIPATIVE SHEET FLOORING

A. Static-Dissipative Sheet Flooring with Integral Cove base and meeting ASTM F1700 Solid Vinyl; Class 1, Type A.

B. Available Manufacturers: Provide products by one of the following manufacturers or equal:
   1. UpoFloor; Zero.
   2. Shannon; Barenaked CS Sheet
   3. Flexco; Delane ESD Seamless Sheet

C. Product Characteristics:

   1. Thickness: 0.08”.
   2. Electrostatic Propensity AATCC 134< 2.0 kV
   3. Electrical Resistance ASTM F 150 > 50 GΩ
   4. Slip Resistance DCOF (Wet) ANSI B 101.3 Acceptable
   5. Static Coefficient of Friction ASTM C 1028 Pass
   6. Abrasion Resistance w weight loss ASTM D 4060 < 0.05 g / 1000 cycles
   7. Castor Chair Test 25.000 cycles EN 425 Pass
   8. Critical Radiant FluxASTM E 648 ≥ 0.45 W/cm2 Class 1
   9. Smoke Density ASTM E 662 ≤ 450 Flaming & Non-flaming
   10. Flexibility ASTM F 137 Pass (8 mm mandrel)
   11. Resistance to Heat ASTM F 1514 Pass
   12. Resistance to Light ASTM F 1515 Pass
   13. Short Term Indentation ASTM F 1914 0.003” at 75 lbs
   14. Chemical Resistance ASTM F 925 Excellence
   15. Static Load Limit ASTM F 970 0.001”
   16. Static Load Limit ASTM F 970 Mod 2000 psi
   17. Improvement in Impact Insulation Class (ΔIIC) ASTM E 2179-09 9
   18. Size: Refer to Finish Legend.
   19. Colors and Patterns: See Finish Schedule.

2.3 RF03: STATIC DISSIPATIVE RUBBER FLOORING

A. :ASTM F1344 Standard Specification for Rubber Floor Tile, Type 1 and Grade. Homogeneous rubber compound with a random scattered design. Electrostatically dissipative floorings for optimum ESD protection of electronic devices and equipment.

B. Available Manufacturers: Provide products by one of the following manufacturers or equal:

   1. Nora; Signa/Environcare ED..
   2. Polyflor; Palletone SD
   3. Flexco; ESD Rubber (heat welded for seamless sheet)

C. Product Characteristics:

   1. Thickness: 0.08 inches.
   2. Surface: Smooth.
   3. Flammability (E648/NFPA 253): ≥ 0.45 watts/sq. cm for Class 1.
   4. Smoke Density (ASTM E662/NFPA 258): NBS, 81 (flaming) and 122 (non-flaming)
   5. Slip Resistance (ASTM D2047): Static coefficient of friction, Neolite dry 0.92, Neolite wet 0.89
   6. Static Generation (ANSI ESD S97.2): < 20 Volts
   7. Decay Time (FTM 101 C 4046): < 0.25 (sec)
   8. Conductivity (ASTM F150): 106 < 109 (ohms)
   9. Thermal Transmission (ASTM C518): R-value 0.01
   10. Size: Refer to Finish Legend.
   11. Colors and Patterns: See Finish Schedule.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor covering system to ground connection.

C. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR, Subpart D (EPA Method 24):

1. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.

D. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.

E. Vinyl Weld Rod: Provide manufacturer's solid color vinyl weld rod intended for heat welding of seams. Color shall be compatible with field color of flooring as selected by Architect.

F. Integral-Flash-Cove Base Accessories:

1. Cove Strip: 1-inch radius support strip provided or approved by manufacturer.
2. Cap Strip: provided or approved by manufacturer.
3. Corners: Metal inside and outside corners and end stops provided or approved by floor covering manufacturer.

G. Maintenance Floor Tiles: Special floor tiles inscribed "Conductive floor. Do not wax."

H. Floor Polish: Provide protective, static-control liquid floor polish products <u>ONLY as recommended by floor covering manufacturer.</u>

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings and electrical continuity of floor covering systems.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   a. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor coverings until they are same temperature as space where they are to be installed.

1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.2 INSTALLATION, GENERAL

A. Install static-control resilient floor covering according to manufacturer's written instructions.

B. Embed grounding strips in static-control adhesive. Extend grounding strips beyond perimeter of static-control resilient floor covering surfaces to ground connections.

C. Scribe, cut, and fit floor coverings to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

D. Extend floor coverings into toe spaces, door reveals, closets, and similar openings. Extend floor covering to center of door openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

F. Adhere floor coverings to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

G. Integral-Flash-Cove Base: Cove floor coverings 6 inches up vertical surfaces. Support floor coverings at horizontal and vertical junction with cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.

1. Lay floor tiles square with room axis

C. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

1. Lay static-dissipative, vinyl composition floor tiles with grain running in one direction

D. Testing: Engage a qualified testing agency to test electrical resistance of static-control resilient floor covering systems for compliance with requirements.

1. Arrange for testing after installation static-control adhesives have fully cured and floor covering systems have stabilized to ambient conditions and after ground connections are completed.
2. Arrange for testing of floor coverings after performing floor polish procedures.

E. Static-control resilient floor coverings will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.

B. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

1. Do not wax static-control resilient floor coverings.
2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties to floor covering surfaces that are free from soil, static-control adhesive, and surface blemishes.

a. Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces floor coverings' effectiveness for static control.

C. Cover floor coverings until Substantial Completion.

D. Floor Polish: Provide protective, static-control liquid floor polish products as ONLY as recommended by floor covering manufacturer.

END OF SECTION 096536

SECTION 096623 - TERRAZZO FLOOR TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Terrazzo floor tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's specifications, technical data, application instructions, and recommendations for each resilient terrazzo floor tile required.

B. Samples for Verification: Full-size units of each color and pattern of resilient terrazzo floor tile required.

1.4 INFORMATION SUBMITTALS

A. Certification for Fire Test Performance: Submit certification from an independent testing laboratory that resilient terrazzo flooring complies with fire test performance requirements.

B. Certifications: Submit certifications from manufacturer that resilient terrazzo flooring complies with specified performance requirements.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resilient products to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer: Provide each type of resilient terrazzo flooring and accessories as produced by a single manufacturer, including recommended primers, adhesives, sealants, and leveling compounds.

B. Installer Qualifications: Engage an installer with a minimum of 5 years of successful commercial resilient terrazzo floor tile installations similar in material, design, and scope to that indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store tiles on flat surfaces.

1.8 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After postinstallation period, maintain temperatures within range recommended by manufacturer.

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

F. Do not install resilient flooring over concrete slabs until the latter have been cured and are sufficiently dry to achieve bond with adhesive as determined by resilient flooring manufacturer's recommended bond and moisture test.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 3 boxes, of each type, color, and pattern of floor tile installed.

PART 2 - PRODUCTS

2.1 TERRAZZO FLOOR TILE

A. Manufacturers and Products:

1. (Basis of Design) Nurazzo Terrazzo.
2. Acceptable: "Friztile" by Expanko Inc.

B. Colors and Patterns: As indicated in the Interior Finish Schedule.

1. Thickness 1/4”
2. Size As shown on drawings

C. Aggregate: Glass chips as recommended by manufacturer to comply with performance requirements.

D. Matrix: Flexible polyester resin as recommended by manufacturer.

E. Wearing Surface: Smooth.

F. Finish: Urethane coating.

2.2 PERFORMANCE REQUIREMENTS

A. Provide Standard: The material is to comply with the following standards and provide the minimum results shown:

Abrasive Resistance – ASTM D-4060	35 mg
Impact Resistance – MILD3134F	Withstands 16 ft/lbs without cracking, delamination or chipping
Slip Resistance – ASTMD-2047	
Wet	.62
Dry	.85
Compressive Strength – ASTM C-579, 7 days	10,000 psi minimum
Tensile Strenth – ASTM C-307	2,500 psi
Flame Spread – ASTM D-84	20
Smoke Generation – ASTM E-622	
Flaming	124
Non-Flaming	20
Fire Rating	Class A
Water Absorption – ASTM D-570	0.01%
Freeze Thaw – ASTM 6-1026	No Effect
Stain Resistance – ASTMD-2299	Completely removed after 24 hours
Toxicity Material SAfety Data	Negative
Critical Radiant Flux – ASTM D-648	1.0 (Class 1)
Fungus and Bacteria Growth – MIL-F-5205	Will not support growth of fungus or bacteria when subjected to mildew and bacteria tests
Indentation – MIL-D3134f	Withstands 2,000 lbs/sq. in. for 30 minutes without indentation
Flexuaral Strength – ASTM C-580	3,000 psi
Thermal Coefficient of Expansion – ASTM -531	21×10^{-6}

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.

B. Adhesives: Thin-bed mortar as recommended by manufacturer.

C. Sealer: Slip resistant, thin-coat sealer of or approved by resilient terrazzo floor tile manufacturer, which will provide a static coefficient of friction of not less than 0.6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

3. Moisture Testing as recommended by manufacturer.

C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.

E. Move terrazzo tiles products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

1. Do not install resilient products until they are same temperature as space where they are to be installed.

F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 TILE INSTALLATION

A. Install Terrazzo Tile according to manufacturer's written insturction.

B. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis unless otherwise indicated.

C. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction, unless otherwise indicated.

D. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.

E. Extend tiles into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. amp-mop surfaces to remove marks and soil. Do not wash surfaces until after time period recommended by manufacturer.

B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

1. Apply protective floor polish to horizontal surfaces that are free from soil, visible adhesive, and surface blemishes if recommended in writing by manufacturer.

a. Use commercially available product acceptable to manufacturer.

2. Cover products installed on horizontal surfaces with undyed, untreated building paper until Substantial Completion.
3. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096623

SECTION 096625 -- WATER VAPOR EMISSION CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes water vapor emission control systems with epoxy-resin body coats to be used if floor slabs do not meet testing requirements for Moisture Vapor Emission Rates as required for interior floor finishes listed below in related sections.

1. Application Method: Roller or squeegee.

B. Related Sections:

1. Division 09 “Resilient Sheet Flooring”
2. Division 09 “Resilient Tile Flooring”
3. Division 09 “Static-Control Resilient Flooring”
4. Division 09 “Terrazzo Flooring”
5. Division 09 “Resinous Flooring”
6. Division 09 “Tile Carpeting”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each water vapor emission control systems component required.

B. Shop Drawings: Show locations and extent of water vapor emission control systems. Show floor finish plans with the following information:

1. Moisture vapor emission rate initial test results.
2. Alkalinity initial test results.
3. Manufacturer's water vapor emission control systems recommendations.

1.4 INFORMATION SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for current formulation of water vapor emission control systems. Provide reports on the following:

1. Moisture Vapor Emission Rate: ASTM F 1869.
2. Water Vapor Permeance: ASTM E 96.
3. Water Vapor Transmission Reduction: ASTM E 96.
4. Alkaline Resistance: ASTM D 1308.
5. Bond Strength: ASTM D 4541.

6. System Chemical Resistance: ASTM D 1308.

C. Compatibility and Adhesion Test Reports: From water vapor emission control systems manufacturer, indicating the following:

1. Materials that will contact or affect water vapor emission control systems have been tested for compatibility and adhesion with water vapor emission control systems.

D. Material Certificates: For each water vapor emission control systems component, signed by manufacturer.

E. Field Inspection Reports: Manufacturer's technical representative's inspection reports.

F. Field Testing Reports: For moisture vapor emission rate testing and alkalinity testing.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer (applicator) who has at least five years' experience in applying water vapor emission control systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to water vapor emission control systems manufacturer.

1. Engage an installer who is certified in writing by water vapor emission control systems manufacturer as qualified to apply water vapor emission control systems indicated.

B. Source Limitations: Obtain primary water vapor emission control systems materials, including primers, resins, and hardening agents, through one source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Preconstruction Compatibility and Adhesion Testing: Submit to water vapor emission control systems manufacturers, for testing indicated below, samples of materials that will contact or affect water vapor emission control systems.

1. Use manufacturer's standard test method to determine whether materials, including flooring substrates, primers, adhesives, and floor finishes, are compatible with and will obtain rapid optimum adhesion to substrates treated with water vapor emission control systems.

D. Adhesives for Floor Finishes: Adhesives for floor finishes shall be 100 percent solids, unless otherwise approved by water vapor emission control systems manufacturer and floor finishes manufacturer.

1. If water based adhesives are proposed for floor finishes, provide an approved underlayment system as recommended by water vapor emission control systems manufacturer and floor finishes manufacturer.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1. Storage areas shall be dry, well ventilated, and have a minimum temperature of 50 degrees F and a maximum temperature of 90 degrees F.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with water vapor emission control systems manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting water vapor emission control systems application.

1. Do not apply water vapor emission control systems when ambient and substrate temperatures are less than 50 degrees F or more than 90 degrees F.

B. Close spaces to traffic during water vapor emission control systems application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

1.8 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by water vapor emission control systems manufacturer agreeing to repair or replace water vapor emission control systems that do not comply with requirements or that do not remain compliant with requirements within specified warranty period.

1. Warranty includes removing and replacing flooring substrates, primers, adhesives, and finish flooring materials.

2. Warranty Period: 10 years after date of Material Completion.

B. Special Installer's Warranty: Written water vapor emission control systems Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and replacing flooring substrates, primers, adhesives, and finish flooring materials.

PART 2 - PRODUCTS

2.1 WATER VAPOR EMISSION CONTROL SYSTEMS

A. Manufacturers and Products: provide one of the following or equal.

1. Aquafin; Vaportight Coat SG2.
2. ARDEX MC ULTRA, manufactured by ARDEX Engineered Cements.
3. Koester American Corporation; Koester VAP I 2000 System.

B. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Body Coats:

   a. Resin: Epoxy.
   b. Formulation Description: 97 percent solids minimum with chemical additives to provide specified water vapor emission control, alkaline resistance, and compatibility with flooring substrates, primers, and adhesives approved by flooring manufacturer.
   c. Application Method: Roller or squeegee.

      1) Spreading Rate: As recommended by manufacturer to comply with requirements.
      2) Number of Coats: One, unless otherwise required to comply with requirements or recommended by manufacturer.
   d. Aggregates: Natural silica.

2. Primer: Type recommended by manufacturer for substrate and body coats indicated.

   a. Formulation Description: High solids with chemical additives to provide specified water vapor emission control, alkaline resistance, and compatibility with body coats.

C. System Physical Properties: Provide water vapor emission control systems with the following minimum physical property requirements when tested according to test methods indicated:

1. Moisture Vapor Emission Rate: Water vapor emission control systems shall reduce moisture vapor emissions of concrete slabs to 3 lb of water/1000 sq. ft., maximum, per ASTM F 1869.
2. Water Vapor Permeance: 1.0 perm, maximum, per ASTM E 96.
3. Water Vapor Transmission Reduction: 90 percent minimum compared to untreated concrete, per ASTM E 96.
4. Alkaline Resistance: Resistant to alkali up to pH 14 per ASTM D 1308.
5. Bond Strength: 375 psi, minimum, at 28 days on moist or dry concrete per ASTM D 4541.

D. System Chemical Resistance: Test specimens of cured water vapor emission control systems are unaffected when tested according to ASTM D 1308 for 50 percent immersion in the following reagents for not less than 7 days:

1. Acetic Acid: 5%.
2. Benzine.
3. Distilled Water.
4. Hydrochloric Acid: 10%.
5. Phosphoric Acid: 25%.

6. Sulphuric Acid: 40%.

2.2 ACCESSORY MATERIALS

A. Patching and Fill Material: Resinous product of or approved by water vapor emission control systems manufacturer and recommended by manufacturer for application indicated.

B. Joint Sealant: ASTM C 920, elastomeric two-part polyurethane polymer sealant; of type, grade, class, and use classifications recommended by water vapor emission control systems manufacturer for type of service and joint condition indicated. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to water vapor emission control systems manufacturer's written instructions for substrate indicated. Provide clean substrate for water vapor emission control systems application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with water vapor emission control systems.

1. Roughen concrete substrates as follows:

   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
   b. Do not acid etch concrete substrates.
2. Repair damaged and deteriorated concrete according to water vapor emission control systems manufacturer's written recommendations.
3. Verify moisture vapor emission rate for concrete substrates.

   a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 25 lb of water/1000 sq. ft. of slab in 24 hours.

4. Verify that concrete substrates have maximum pH 14 and that water vapor emission control systems will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to water vapor emission control systems manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks according to water vapor emission control systems manufacturer's written recommendations.

3.2 APPLICATION

A. General: Apply components of water vapor emission control systems according to manufacturer's written instructions to produce a uniform, monolithic surface.

1. Coordinate application of components to provide optimum adhesion of water vapor emission control systems system to substrate, optimum intercoat adhesion, and optimum adhesion to flooring substrates, primers, and adhesives approved by flooring manufacturer.
2. Cure water vapor emission control systems components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. At substrate expansion and isolation joints, provide joint in water vapor emission control systems to comply with water vapor emission control systems manufacturer's written recommendations.

a. Apply joint sealant to comply with manufacturer's written recommendations.

B. If water vapor emission control systems manufacturer recommends a primer, apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Apply body coats by roller or squeegee at spreading rates recommended in writing by manufacturer.

1. If aggregates are recommended by water vapor emission control systems manufacturer, broadcast aggregates according to manufacturer's written instructions. After resin is cured, remove excess aggregates.

D. Apply additional body coats, if necessary, at spreading rates recommended in writing by manufacturer to comply with requirements as demonstrated through testing.

E. Concrete Slabs on Grade: Provide water vapor emission control systems on all concrete slabs on grade scheduled to receive epoxy terrazzo floor finish.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Technical Representatives Inspection: The Contractor shall arrange and pay for the water vapor emission control systems manufacturer's technical representatives to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

B. Moisture Vapor Emission Rate Testing: Perform anhydrous calcium chloride test, ASTM F 1869, on concrete slabs with water vapor emission control systems. Perform one test per 1000 sq. ft..

1. After anhydrous chloride testing, apply additional coat of water vapor emission control systems material to all slab areas where the moisture-vapor-emission rate exceeds 3 lb of water/1000 sq. ft. of slab in 24 hours.

2. Additional testing, at Contractor's expense, shall be performed to determine compliance of corrected Work with requirements. Apply additional coat of water vapor emission control systems material and retest until all substrates pass testing.

C. Alkalinity Testing: Perform alkalinity tests on concrete slabs using test methods recommended by manufacturer. Verify that concrete substrates have a neutral pH and that flooring substrates, primers, and adhesives approved by flooring manufacturer will adhere to them. Apply additional

coat of water vapor emission control systems material and retest until all concrete substrates pass testing.

3.4 CLEANING AND PROTECTING

A. Protect water vapor emission control systems from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by water vapor emission control systems manufacturer.

END OF SECTION 096625

SECTION 096723 -- RESINOUS FLOORING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Self-leveling resinous flooring system with seamless urethane body installed over existing tile flooring.
    a. Application method: metal, power or hand troweled.

B. Related Sections:

1. Division 09 “Water Vapor Emission Control Systems” for moisture mitigation products and installation.

1.3 PERFORMANCE REQUIREMENTS

A. Dynamic Coefficient of Friction (DCOF): For seamless flooring installed on walkway surfaces, provide products with the following values determined by testing identical products using the DCOF AcuTest, using the BOT-3000 to measure slip resistance of flooring, with the following minimum requirement for floor surfaces in wet or dry.

1. Level Surfaces and Treads: Minimum 0.42.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, installation instructions, and general recommendations for each resinous flooring material required. Include certification indicating compliance of materials with requirements.

B. Shop Drawings:

1. Floor plans indicating locations of all joints, material transitions and special conditions.

2. Details indicating manufacturer’s recommendations for treatment of terminations, floor drains, control joints, cold joints, cracks and other conditions.

C. Samples for Selection: Provide custom and standard color samples and samples of finishes for Architect’s selection.

D. Samples for Verification: Provide each color and finish sample on 24” x 24” applied to floor tile and backer board to demonstrate quality of finished product. Product Schedule: Use Urethane flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.

E. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

F. Survey Existing Tiles Floor: See Part 3 “Execution.”

G. Material Test Reports: For each resinous flooring component.

H. Material Certificates: For each resinous flooring component, signed by manufacturer.

I. VOC Content: Manufacturers' statement of VOC content for floor coatings.

1. Certification: Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

J. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain primary resinous flooring materials, including resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer with not less than 10 years of successful experience in the manufacture and installation of the principal Urethane flooring materials and systems specified herein. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

B. Manufacturer Qualifications: A firm experienced in manufacturing resinous flooring system components as required for this Project and with a record of successful in-service performance.

C. Installer Qualifications: Engage an experienced installer (applicator) experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply Urethane flooring systems indicated.

D. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.

1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.

E. ISO 9002: All materials, including primers, resins, curing agents, finish coats, aggregates and sealants are manufactured and tested under an ISO 9002 registered quality system.

F. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 72-inch- square floor area selected by Architect.

b. Include 72-inch length of integral cove base.

2. Simulate finished lighting conditions for Architect's review of mockups.

3. Approved mockups may become part of the completed Work if undisturbed at time of Final Completion.

G. Pre-installation Conference:

1. General contractor shall arrange a meeting not less than thirty days prior to starting work.

2. Attendance:

a. General Contractor
b. Architect/Owner's Representative.
c. Manufacturer/Installer's Representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with Urethane flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting Urethane flooring application.

1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during Urethane flooring application.

C. Close spaces to traffic during Urethane flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

D. Installation over existing quarry tile, prep to include full mechanical prep and patching to prevent telegraphing of mortar joints and cold seam patches.

1.8 WARRANTY

A. Manufacturer's Warranty: one year materials and labor.

PART 2 - PRODUCTS

2.1 RESINOUS FLOORING

A. Description: dense, liquid-rich, self-priming, textured, four-component, notch trowel applied, polyurethane mortar system. Unsealed or "self-sealing" urethane mortar systems, multiple layers of liquids and broadcasts will not be accepted, and will result in a disqualification from bid.

B. Acceptable Manufacturers include the following or equal:

1. (Basis of Design) Stonhard
2. Dur-A-Flex: Dur-A-Chip Epoxy
3. General Polymers; Epoxy Floor Coatings

C. Products:

1. (Basis of Design) Stonhard, Inc.; Stonclad UT®. With UT Sealer.

D. System Characteristics:

1. Color and Pattern: to be selected by Architect from manufacturer's standard and custom colors.
2. Wearing Surface: Medium texture as approved by architect
3. Integral Cove Base: 4-inches.
4. Overall System Thickness: nominal 3/16-1/4".

E. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Waterproofing Membrane

   a. Material design basis: Stonproof ME7.
   b. Resin: Urethane.
   c. Formulation Description: Elastomeric urethane, High solids.
   d. Substrate Priming: Two coat application per product directions.
   e. Application Method: 30 mil notched squeegee.

2. Mortar:

   a. Material design basis: Stonclad UT
   b. Resin: Urethane.
   c. Formulation Description: (4) four-component, 100 percent solids.
   d. Application Method: Screed, Trowel.
      1) Thickness of Coats: 3/16".
      2) Number of Coats: One.
      3) Broadcast texture into wet mortar base.
      4) Aggregates: Pigmented Blended aggregate.

2. Top coat:

   a. Material design basis: UT Sealer
   b. Resin: Urethane.
   c. Formulation Description: (2) two-component, 100 percent solids.
   d. Type: pigmented.
   e. Finish: standard.
   f. Number of Coats: One.

3. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

   a. Compressive Strength: 7,700 psi after 7 days per ASTM C 579.
   b. Tensile Strength: 1,000 psi per ASTM C 307.
   c. Flexural Strength: 2,400 psi per ASTM C 580.
   d. Water Absorption: < 1% per ASTM C 413.
   e. Impact Resistance: > 160 in. lbs. per ASTM D 2794.
   f. Flammability: Class 1 per ASTM E-648.
   g. Hardness: 80 to 84, Shore D per ASTM D 2240.

2.2 ACCESSORIES

A. Primers: As recommended by flooring material manufacturer to suit substrate(s).

B. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated.

C. Joint Sealant Materials: Type produced and indicated by manufacturer of resinous flooring system for type of service and joint condition indicated.

D. Termination strips: Stops, Toe and Divider Strips:

   1. Zinc "L"-shaped, depth to match flooring thickness, as recommended by manufacturer. Configuration shall provide for secure anchoring of strips to substrate.

E. Urethane Sealant: As recommended by flooring manufacturer; chemistry to match flooring system. Color: similar to flooring.

F. Reinforcing Membrane: Manufacturer's flexible resin recommended for crack isolation to help prevent substrate cracks from reflecting through resinous flooring. Provide fiberglass scrim embedded in reinforcing membrane as needed and install per manufacturer’s instructions.

G. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions in which resinous flooring systems will be installed.

1. Inspect concrete substrate, walls, and other existing work for conditions which must be corrected before installation can begin. Inform Contractor in writing of all unsatisfactory or incomplete conditions.

2. Verify environmental conditions and completion of work required by other trades. Inform Contractor in writing of all unsatisfactory or incomplete conditions.

3. Inspect concrete substrate, walls, and other existing work for special conditions which must be incorporated into the resinous flooring installation such as control joints, material transitions and patching or leveling.

B. Do not proceed with installations until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare and clean substrate according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminates incompatible with resinous flooring.

C. Concrete preparation shall be by mechanical means using a shot blast machine for removal of bond inhibiting materials such as curing compounds or laitance. Grinding is not acceptable.

1. Comply with ASTM C 811 requirements and manufacturer's requirements.
2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

    a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.
    b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 7 lb of water/1000 sq. ft. of slab in 24 hours.
    c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

D. Use approved patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

F. Moisture Mitigation: apply manufacturer’s approved product or refer to Division 09 “Water Vapor Emission Control Systems” for manufacturers, products and installation.

3.3 INSTALLATION

A. General: Apply each component of resinous flooring system in compliance with manufacturer's directions to produce a uniform monolithic wearing surface of thickness indicated, uninterrupted except at divider strips, or other types of joints indicated on the approved shop drawings.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Install resinous flooring and troweled cove base prior to the installation of the casework, millwork and equipment.

C. Primer coat: Mix and apply primer coat (where indicated or required) over properly prepared substrate with strict adherence to manufacturer's installation procedures and coverage rates. Coordinate timing of primer application with application of troweled mortar to ensure optimum adhesion between resinous flooring materials and substrate.

D. Waterproofing Membrane: Apply waterproofing membrane at substrate surfaces at elevated slabs in manufacturer's recommended thickness.

1. Apply waterproofing membrane to integral cove base substrates.

E. Reinforcing Membrane: Apply reinforcing membrane to as recommended by manufacturer.

F. Troweled Mortar: Mix mortar material according to manufacturer's recommended procedures. Uniformly spread mortar over substrate using manufacturer's specially designed screed box adjusted to manufacturer's recommended height. Hand trowel apply mixed material over freshly primed substrate using stainless steel finishing trowels.

G. Coating: Remove any surface imperfections by lightly abrading and vacuuming the floor surface. Mix coating according to manufacturer's recommended procedures. Mix and apply coating with strict adherence to manufacturer's installation procedures and coverage rates.

H. Integral Cove Base: Apply cove base mix to wall surfaces at all locations.

1. Install cove base according to manufacturer's written instructions and details including taping, mixing, priming, troweling, sanding, and top-coating of cove base.
2. Internal and external corners shall be rounded.
3. Smoothly transition resinous flooring at door frames to provide a smooth and readily cleanable condition.
4. Cove base installation shall provide a seamless transition between the flooring system and wall coating, free of voids or gaps. Terminate top of cove base as follows and as indicated on Drawings:

    a. At concrete masonry and poured in place concrete, terminate by turning base mix into raked or routed wall joint at a consistent height aligned with the first horizontal masonry joint, except where indicated otherwise on Drawings.

b. At gypsum wall board surfaces, terminate at 4” above finished floor with manufacturer’s termination strip accessory as specified in Products section above.

3.4 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

A. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.

B. Owner may invoke the following material testing procedure at any time, and any number of times during period of flooring application.

1. The Owner may engage the service of an independent testing laboratory to sample materials being used on the job site. Samples of material will be taken, identified and sealed, and certified in presence of Contractor.

2. An independent testing laboratory will perform tests for any of characteristics specified, using applicable testing procedures referenced herein, or if none referenced, in manufacturer's product data.

3. If test results demonstrate materials or methods of installation being used do not comply with specified requirements, Contractor may be directed by Owner to stop work; remove non-complying materials; pay for testing; reapply flooring materials to properly prepared surfaces which had previously been coated with unacceptable materials.

C. Sequencing of floor installation shall be after the lighting, ceiling and door frames have been installed and the painting is complete and before the bumper guards, cabinetry, doors and floor mounted equipment has been installed.

3.6 MANUFACTURER'S FIELD SERVICES

A. Provide flooring manufacturer's services to supervise and instruct installers on surface examination and preparation; expansion joint, cold joint and control joint preparation; mixing, application, finishing, curing, and other instruction as required, including supervising corrective measures required to be taken at unsatisfactory conditions.

B. Submit field service reports indicating compliance with or deviation from manufacturer's installation instructions.

3.7 CURING, PROTECTION AND CLEANING

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.

B. Protect resinous flooring materials from damage and wear at all times during construction operation. Comply with manufacturer's recommendations for protective materials and method of application.

C. Cleaning: Remove excess product from other work using methods and materials recommended by manufacturer.

1. Remove surplus materials, rubbish, and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

2. Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 – TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY DEFINITION

A. Section includes:

1. Modular tile carpeting.
2. Walk-off carpet.

B. Related sections:

1. Division 01 “Sustainable Design Requirements” for additional requirements.
2. Division 09 “Resilient Base and Accessories” for wall base.
3. Division 09 “Division 09 “Water Vapor Emission Control Systems” for moisture mitigation of concrete slab.

1.3 REFERENCES AND SELECTION CRITERIA

A. Industry Standards and Tests

1. NFPA 253
2. Floor Covering Installation Board (FCIB)
3. Carpet and Rug Institute (CRI)
4. Floor Covering Installation Contractors Association

B. Applicable Publications

1. CRI 104 Standard for Installation of Commercial Carpet

1.4 ACTION SUBMITTALS

A. Product Data: Manufacturer's Product Data sheets shall be required for each type of tile carpeting, adhesives and accessories specified.

B. Full size samples shall be required for each type of tile carpeting specified.

C. Shop Drawings: Show the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch long Samples.

1.5 INFORMATION SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

1.6 QUALITY ASSURANCE

A. Source Limitations: unless specifically noted otherwise, provide carpet tile of the same manufacturer for each type of carpet specified.

B. Contractor's Qualifications:

1. Employ only experienced Contractors (Installers) skilled in the successful installation of the specified materials and accessories on similar projects for a minimum of five (5) years, acceptable to the carpet tile manufacturer in writing to FPU.

C. Manufacturer (s) Qualification

1. Utilize only manufacturers making the specified materials as a current and regular production item.
2. Manufacturers of specified carpet tiles shall have a minimum of fifteen (15) years of production experience with carpet tiles of similar types and whose published product literature clearly indicates compliance of their product with a particular carpet tile specified.
3. Manufacturer shall provide verification of registration to ISO 9001/9002 Quality Management System and ISO 14001 Environmental Management System.
4. Manufacturer to provide three (3) references of installations in similar facilities.
5. Manufacturer must provide Chain of Responsibility that states they will take back their product for recycling at the end of its useful life.

D. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.8 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.9 WARRANTY

A. Special Tile Carpeting Warranty: Written warranty, non-prorated, signed by carpet tiles manufacturer agreeing to remove and replace tile carpeting installation that fails in materials and workmanship within the specified warranty period.

1. Warranty does not include deterioration or failure of tile carpeting due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include but are not limit to, more than ten percent (10%) loss of face fiber/yarn loss by weight normal use, edge raveling, runs, loss of tuft bind strength, dimensional stability, excess static discharge, delamination and stain resistance.
3. Warranty shall not require the use of chair pads.
4. Warranty Period: Fifteen (15) years from date of Order.
5. Manufacturer shall warranty that dye lots are mergeable.
6. Warranty shall identify the following: Pattern name; pattern color; square yards use. In case of multiple buildings where tile carpeting has been used, identify building name/number and pattern, pattern color, square yards used.

B. Installer's Warranty: The Contractor (Installer) shall fully guarantee the installation against defects in workmanship, seaming and loss of adhesion to floor for a period of one year from the date of substantial Completion. Upon written notice, the Installer shall repair or replace the affected area at no cost to the University.

1.10 EXTRA MATERIALS

A. Provide additional carpet tiles equal to 1% of each type, color and pattern furnished for University use as maintenance stock.

B. This stock shall be designated for use by University only, after completion of the Project, and shall not be used for repair or replacement during Warranty period.

PART 2 - PRODUCTS

2.1 TILE CARPETING

A. General: Provide carpet products that have acceptable VOC emissions levels of the following chemicals when tested in accordance with California Specification 01350 and the CRI "Green Label Plus" program:

1. Acetaldehyde.
2. Benzene.
3. Caprolactam.
4. 2-Ethylhexanoic Acid.
5. Formaldehyde.
6. 1-Methyl-2-Pyrrolidinone.
7. Naphthalene.
8. Nonanal.
9. Octanal.
10. 4-Phenylcyclohexene.
11. Styrene.
12. Toluene.
13. Vinyl Acetate.

B. Acceptable manufacturers include the following or equal:

1. Interface for Commercial
2. Shaw
3. Mannington
4. Miliken

2.2 CARPET TILE TYPES

A. **CPT01:** Carpet Tile

1. Manufacturer, color, model number and style: refer to Finish Schedule.
2. Product Type: Modular
3. Carpet Pile Construction: Tufted Textured Loop
4. Yarn System: 100% Recycled Content Type 6 Nylon.
5. Yarn Manufacturer: Aquafil.
6. Dye Method: 100% Solution Dyed.
7. Dye Lots Mergeable
8. Soil/Stain Protection Protekt²®
9. Preservative Protection Intersept®
10. Tufted Yarn Weight : 18 oz/yd²
11. Machine Gauge: 1/12 in
12. Pile Height: 0.15 in
13. Pile Thickness: 0.095 in
14. Stitches: 8.7/in
15. Pile Density: 6,821 oz/yd³
16. Performance Specifications
    a. Flooring Radiant Panel (ASTM E-648) Class 1
    b. Smoke Density (ASTM E - 662) ≤ 450
    c. Flammability Passes Methenamine Pill Test (DOC-FF1-70)
    d. Lightfastness (AATCC 16 - E) ≥ 4.0 @ 60 AFU's

e. Static(AATCC - 134) < 3.0 KV
f. Dimensional Stability AACHEN Din 54318 <.10%
g. Traffic Classification Heavy
h. Fiber Modification Ratio 1.9 to 2.2
i. Preservative Efficacy (AATCC 174 Parts 2&3) 99% Reduction/No Mold 7 Days (ASTM E-2471) Complete Inhibition

17. Environmental Specifications:
    a. Total Recycled Content 76%
    b. Recycled Content (Post Industrial) 67%
    c. Recycled Content (Post Consumer) 8%
    d. Indoor Air Quality Green Label Plus #GLP0820 Ingredients and Life Cycle Impacts Environmental Product Declaration
    e. Other Environmental Claims 3rd Party Verified Carbon Neutral
    f. NSF/ANSI 140 Gold - Sustainability Assessment
18. Warranty: 15 years.
19. Standard backing: GlasBac

B. **CPT-02:** Entrance Matting: Modular scraper tiles for entrance flooring solutions. Includes tufted cut pile textile inserts manufactured with twisted and heat set polyamide monofilaments, bonded in UV resistant PVC tile carrier.

1. Manufacturer, color, model number and style: refer to Finish Schedule.
2. Wear Resistance: Severe.
3. Total thickness: 16 mm.
4. Yarn: Composition: 100% Econyl ® regenerated solution dyed polyamide twisted and heat set monofilament.
5. Primary backing composition and construction: Polyester non-woven.
6. Pile:
    a. Construction: Cut pile.
    b. Tuft method: Straight Tufted
    c. Pile Height: 13 mm.
7. Dye: Solution dyed.
8. Tile Construction:
    a. Composition: 100% PVC
    b. Backing thickness: 16mm
9. Performance Testing:
    a. Flammability Low radius of effect (BS 4790 Hot Nut Test)
    b. Wear Resistance Pass at 66,000 cycles (Vettermann Drum)
    c. Slip Resistance DS (0.57) (EN 13893)
    d. Antistatic Behaviour Approx. 1012ohms (ISO 10965)
    e. Personal Charging <2.0kV (antistatic) (ISO 6356)
    f. Static Load Resistance To be confirmed (BS 4939)
10. Tile Size: Nominal 200 x 200mm.

2.3 INSTALLATION ACCESSORIES

A. Provide rubber tile carpeting transition divider strip/nosing between carpet tile and other flooring when total thickness of each material is not equal and where shown in documents.

1. Stainless steel transitions in Lobby.
2. Divider strips and nosing to be selected by Design Professional from manufacturer's standard.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

1. Adhesives shall have a VOC content of 50 g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. Carpet manufacturer may provide moisture mitigation system or refer to Division 09 “Water Vapor Emission Control Systems” for requirements.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

H. Releaseable installation method:

1. Install tile carpeting using releasable installation method. Comply with CRI 104, Section 13, Carpet Modules (tiles).

2. Provide adhesive free system that suits subfloor conditions indicated and complies with flammability requirements for installed carpet tile.

3. As an alternate, if prior approval is obtained from University representative, provide water-resistant, mildew-resistant, non-staining, pressure-sensitive adhesive to suit products and subfloor conditions indicated; that complies with flammability requirements for installed carpet tile and recommended by carpet tile manufacturer for releasable installations.

I. Where tile carpeting does not continue beyond a door to another room, extend carpet tile into the door reveals so that carpet tile stops under door when door is in a closed position.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 16 "Protection of Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

3.5 OPERATIONS AND MAINTENANCE

A. Cleaning

1. The tile carpeting manufacturer shall provide instructions to designated University personnel on the proper methods and procedures for cleaning tile carpeting material.

2. Tile carpeting manufacturer shall provide a representative to demonstrate cleaning and stain removal processes to University maintenance personnel at:
   a. 30 days prior to substantial completion;
   b. (6) months from date of Substantial Complete and;
   c. (11) Months from date of Substantial completion.

END OF SECTION 096813

SECTION 097800 -- INTERIOR WALL PANELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. WP01: Monolithic sculptured wall surfaces composed of solid mineral composite profile paneling at Lobby/Entrance and Pre-function and as indicated.

B. Related Sections:

1. Division 09 "Gypsum Board Assemblies" for substrate and seam finishing.
2. Division 09 "Interior Painting" for sealing and painting of modular wall..

1.3 REFERENCES

A. The following references and standards apply to basis of design product:
1. ASTM D 256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
2. ASTM D 696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 C and 30 C With a Vitreous Silica Dilatometer.
3. NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior finish to Room Fire Growth.
4. ASTM E 84 Standard Test Methods for Surface Burning Characteristics of Building Materials.
5. GA-214 Recommended Levels of Gypsum Board Finish.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show standard and project specific details including termination at adjacent surfaces.

C. Samples for verification: Submit samples no less than 15" x 15"for all specified material finishes.

1.6 INFORMATION SUBMITTALS

A. Manufacturer's installation instructions.

B. Qualification Statements: Proof of manufacturer, installer, and finisher qualifications.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For interior wall paneling to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Minimum 5 years' experience in producing mineral profile paneling.
2. Installer Qualifications: Minimum three years' experience in the installation of wall systems.
3. Finisher: Minimum three years' experience in executing Level 5 finish in accordance with GA-214.

B. First Installed Work: To verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.

1. Provide a representative sample of installed product including finished seam.
2. Approved field samples shall become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE AND HANDLING

A. Storage and Handling Requirements:

1. Store panels in fully enclosed space, protected against damage from moisture, direct sunlight, and surface contamination.
2. Store panels vertically, in shipping crates, until ready to be installed. Loosen crate lids to allow for venting. Do not stack or lean against walls.
3. Store panels in area of installation minimum 24 hours prior to installation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting solid mineral profile paneling installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with solid mineral profile paneling by field measurements before fabrication.

C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during solid mineral profile paneling installation.

D. Control and collect dust produced by solid mineral profile paneling installation. Protect adjacent construction from detrimental effects.

1. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.11 COORDINATION

A. Secure field measurements before preparation of shop drawings and fabrication where possible, for fabrication and installation of the work.

1.12 WARRANTY

A. Provide manufacturer's standard limited warranty.

PART 2 - PRODUCTS

2.1 WP01: WALL PANELING

A. Manufacturers and products

1. (Basis of Design): Modular Arts; "Clif"
2. Acceptable manufacturers include:

a. Interlam; "Shattered Screen."
b. Koroseal; "Sculpted Wall Panels."

2.2 COMPONENTS

A. Profile Panel: Smooth surface mineral composite panel with light weight plant-based foam back.

1. Size: 32 by 32 by 1.5 inch maximum profile relief.
2. Physical Properties:

a.	Izod Impact Strength: ASTM D 256	9.4 ft-lb/in2
b.	Thermal Expansion: ASTM D 696	3.8x10-7in/in °F.
c.	Compressive Strength: ASTM D 696	2.3 ksi.
d.	Room Corner Burn Test: NFPA 286	Pass
e.	Flame Spread Index: ASTM E 84	0
f.	Smoke Development Index: ASTM E 84	50
g.	Weight (for all designs excluding MUDD formerly YUMA)	1.5 psf

B. Installation kit: As provided by manufacturer.

2.3 ACCESSORIES

A. Anchors: 30 lb self-drilling, drywall anchor.

B. Screws: Coarse thread, drywall type, length as required by panel design and in accordance with Manufacturer's Installation Instructions.

2.4 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:

1. Dimensions, length and width: +/- 1/16 inch.
2. Thickness: +/- 1/16 inch.
3. Weight: +/- 0.5 lb

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Verify that substrate is a material listed as an acceptable substrate by the profile paneling manufacturer.
2. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.
3. Verify that permanent project lighting is in place and operational prior to start of seam finishing.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair installation of paneling.

3.3 INSTALLATION

A. Install profile paneling in accordance with Manufacturer's Installation Instructions.

1. Coordinate seam finishing with Division 09 Section - Gypsum Board.
2. Coordinate sealing and painting with Division 09 Section - Interior Painting.

3.4 CLEANING AND PROTECTION

A. Remove dust from installation and adjacent areas.

B. Clean surfaces with cleaner according to manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that paneling is without damage or deterioration at time of Substantial Completion.

END OF SECTION 097813

SECTION 099113 -- EXTERIOR PAINTING AND ELASTOMERIC COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Galvanized metal.
4. Aluminum (not anodized or otherwise coated).
5. Concrete pavement.
6. Exterior Gypsum Board Substrates

B. Paint exposed surfaces, whether or not colors are designated in schedules, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Light fixtures.
b. Heating unit enclosures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.
b. Furred areas.
c. Utility tunnels.
d. Pipe spaces.

3. Finished metal surfaces include the following:

a. Kynar coated aluminum.
b. Stainless steel.

c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
2. Division 09 painting Section "High-Performance Coatings" for special-use coatings.

1.3 DEFINITIONS

A. General: Standard painting terms defined in ASTM D 16 apply to this Section.

B. Exterior Surfaces: Exterior surfaces to be painted are defined as those surfaces which are indicated in areas exposed to conditions which are not controlled by building heating and cooling systems.

C. Interior Surfaces: Interior surfaces to be painted are defined as those surfaces which are indicated in areas exposed to conditions which are controlled by building heating and cooling systems.

D. MPI Gloss and Sheen Standards: As follows when tested in accordance with ASTM D 523.

1. Gloss Level 1: A traditional matte finish – flat.

a. Gloss Measured at 60 degrees: Maximum 5 units.
b. Sheen Measured at 85 degrees: Maximum 10 units.

2. Gloss Level 2: A high side sheen flat – velvet.

a. Gloss Measured at 60 degrees: Maximum 10 units.
b. Sheen Measured at 85 degrees: 10 to 35 units.

3. Gloss Level 3: A traditional egg-shell finish.

a. Gloss Measured at 60 degrees: 10 to 25 units.
b. Sheen Measured at 85 degrees: 10 to 35 units.

4. Gloss Level 4: A satin finish.

a. Gloss Measured at 60 degrees: 20 to 35 units.

b. Sheen Measured at 85 degrees: Minimum 35 units.

5. Gloss Level 5: A traditional semi-gloss.

a. Gloss Measured at 60 degrees: 35 to 70 units.

6. Gloss Level 6: A traditional gloss.

a. Gloss Measured at 60 degrees: 70 to 85 units.

7. Gloss Level 7: A high gloss.

a. Gloss Measured at 60 degrees: More than 85 units.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 12-inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Resubmit until required gloss, sheen, color, and texture are achieved.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted. Variation from the "MPI Approved Products List" is not allowed.

1.5 INFORMATION SUBMITTALS

A. Qualification Data: For applicator.

B. Maintenance Date: To be included in Operation and Maintenance manuals.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

D. Regulatory Requirements: Provide products that comply with local regulations controlling use of volatile organic compounds (VOCs).

E. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100-sq. ft.

b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on benchmark samples.

a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45-deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Protect from freezing.

1.8 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95-deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5-deg F above the dew point; or to damp or wet surfaces.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1-gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers and as listed in paint types below:

1. Behr
2. Benjamin Moore
3. Colombia Paint
4. Coronado Paint
5. PPG Architectural Coatings
6. Sherwin-Williams

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Exterior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:

1. Restricted Components: Paints and coatings shall not contain any of the following:

a. Lead.
b. Mercury.

C. Colors: As indicated in a color schedule.

2.3 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.

1. Products: provide one of the following or approved equal:

a. Behr Pro; Block Filler.
b. Benjamin Moore; Moorcraft, Super Craft Latex Block Filler, 285-01.
c. Coronado Paint; Super Kote 5000, Commercial Latex Block Filler, 946-11.
d. PPG; Speedhide Interior/Exterior masonry Hi Fill latex block filler.
e. Sherwin-Williams; PrepRite, Int/Ext Block Filler, B25W25.

2.4 METAL PRIMERS

A. Waterborne Galvanized-Metal Primer: MPI #134.

1. Products: provide one of the following or approved equal:

a. Behr Premium Plus; Exterior Multi-Surface Primer & Sealer.
b. Benjamin Moore; Ultra Spec HP Acrylic Metal Primer.
c. PPG, High Performance Coatings; Pitt-Tech Plus.
d. Sherwin-Williams; Protective & Marine, DTM Acrylic Primer/Finish.

B. Alkyd Primer, Anti-Corrosive for Metal: MPI # 79

1. Manufacturers and Products:

a. Moore: Super Spec HP Alkyd Metal Primer
b. PPG; Multiprime 4160/Devguard 4160
c. S-W; Kem Bond HS Universal Alkyd Primer.

C. Quick-Drying Primer for Aluminum: MPI #95.

1. Products: provide one of the following or approved equal:

a. Diamond Vogel; Iron Prime 600 Fast Dry Universal Primer
b. Hempel A/S; Hempel's Metal Primer
c. Masterchem Industries; Kilz Complete Int/Ext Oil-Based Primer
d. Rodda Paint Co; Barrier III High Solids Primer
e. Sherwin-Williams; Kem Kromik, Universal Metal Primer – Off White, B50WZ1.

2.5 WATER-BASED, LIGHT-INDUSTRIAL COATINGS

A. Gloss, Water-Based, Light-Industrial Coating: MPI #164 (Gloss Level 6).

1. Products: provide one of the following or approved equal:

a. Cloverdale Paint; EcoLogic, Waterborne Gloss
b. Sherwin-Williams; Pro Industrial DTM Acrylic Gloss.

2.6 ELASTOMERIC COATINGS FOR MASONRY AND CONCRETE

A. Exterior Concrete and Masonry: Elastomeric Coatings: 2 finish coats over primer.

1. Manufacturers and Products:

a. Primer: Latex Primer MPI #3

Behr Premium:	Exterior Multi-Surface Primer & Sealer
PPG:	Perma-Crete Interior/Exterior Alkali Resistant Primer
S-W:	Loxon Concrete and Masonry Primer

b. Finish Coats: Elastomeric, Pigmented Exterior, Water Based Flat MPI #113

Behr Premium:	Exterior Elastomeric Masonry, Stucco
PPG:	Perma-Crete Pitt-Flex Elastomeric Coating
S-W:	Sherlastic Elastomeric Coating

2.7 EXTERIOR GYPSUM BOARD SUBSTRATES

A. Exterior Gypsum Board: 2 finish coats over primer.

1. Manufacturers and Products:

a. Primer: Latex Primer MPI #6.

Behr Premium	Exterior Multi-Purpose Primer
Moore:	Ultra Spec EXT Latex Exterior Primer.
PPG:	Seal Grip Int/Ext Acrylic Universal Primer/Sealer
S-W:	Exterior Latex Wood Primer

b. Finish Coats: Low sheen MPI #15 (MPI Gloss Level 3-4)

Behr Pro	Exterior Satin
Moore:	Ultra Spec Exterior Satin Finish
PPG:	Speedhide Exterior 100% Acrylic Latex Satin
S-W:	Emerald Exterior Acrylic Satin

2.8 TRAFFIC MARKINGS

A. Traffic-Marking Paint, Latex: MPI #97.

1. Products: provide one of the following or approved equal:

a. Benjamin Moore Coronado Paint; Super Kote 50Quick Dry Acrylic Paint.
b. PPG Architectural; Zoneline Traffic and Zone Stripping Paint.
c. Sherwin-Williams; Protective & Marine, Setfast Acrylic Waterborne Traffic Paint,

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

2. Masonry (Clay and CMU): 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Use cleaning methods recommended by paint manufacturer. Determine moisture content and alkalinity of surfaces by performing appropriate tests. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Use cleaning methods recommended by paint manufacturer. Determine moisture content and alkalinity of surfaces by

performing appropriate tests. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Galvanized-Metal Substrates: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil, grease, soil, and other coluble contaminants in accordance with SSPC SP-1 "Solvent Cleaning." Pretreat in accordance with the recommendations of SSPC "Good Painting Practice, Vol. 1, Chapter 22."

1. Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

2. If galvanized metal substrates have been passivated or stablilzed, the coating shall be completely removed in accordance with SSPC-SP 7/NACE No. 4 "Brush-Off Blast Cleaning." Galvanized steel to be painted shall not be passivated or stablilized.

G. Aluminum Substrates: Remove surface oxidation.

H. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Apply paint in accordance with MPI Painting Manual Premium Grade finish requirements.

2. Paint colors, surface treatments, and finishes are indicated in the paint schedules.

3. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

4. Use applicators and techniques suited for paint and substrate indicated.

5. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

6. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

7. Access panels, electrical panels, supply and exhaust grilles, louvers, exposed conduit, primed hardware items, primed outlet covers, primed wall and ceiling plates and other items in painted areas shall be painted to match the areas in which they occur unless otherwise directed by the Architect.

8. Finish exterior doors to tops, bottoms, and side edges the same as exterior faces.

9. Sand and dust between each coat to provide an anchor for next coat and to remove visible defects.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. Omit primer over metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

F. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.

2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

G. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

H. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:

1. Mechanical Work:

a. Uninsulated metal piping.

b. Uninsulated plastic piping.

c. Pipe hangers and supports.

d. Tanks that do not have factory-applied final finishes.

e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets. Paint with primer and one coat of matt black (non-reflecting) paint.

f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

g. Mechanical equipment that is indicated to have a factory-primed finish for field painting. Paint to match areas in which they occur, unless otherwise directed by the Architect.

h. Accessory items.

2. Electrical Work:

a. Panelboards.

b. Electrical equipment that is indicated to have a factory-primed finish for field painting.

c. Conduit and fittings.

I. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

J. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 TRAFFIC MARKINGS

A. Do not apply traffic-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting traffic marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce traffic markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.5 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:

1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will perform tests for compliance of paint materials with product requirements.

3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.6 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. Provide "Wet Paint" sign to protect newly painted finishes.

C. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

D. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 EXTERIOR PAINTING SCHEDULE

A. CMU and Concrete (non-traffic) Substrates: Exterior High-Build Latex (Elastomeric) Paint over Alkali resistant Primer System. Dry film thickness of not less than 10 mils.

1. Block Filler (at CMU) MPI #4
2. Prime Coat: alkali resistant, water based, MPI #3
3. Intermediate Coat: Water-based latex high-build matching topcoat.

4. Topcoat: Latex, exterior, flat (MPI Gloss Level 1) , MPI #113.

B. Exterior Steel Doors and Frames: Water-Based Light Industrial Coating System

1. Prime Coat: Primer, rust inhibitive, water based[MPI #107].
2. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
3. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5) [MPI #153].

C. Galvanized-Metal Substrates:

1. Water-Based, Light-Industrial Coating System: MPI EXT 5.3G

a. Prime Coat: Waterborne galvanized-metal primer, MPI #134.
b. Intermediate Coat: Water-based, light-industrial coating, MPI #163 gloss matching topcoat.
c. Topcoat: Water-based, light-industrial coating, gloss, MPI #163, MPI gloss level 5

D. Aluminum Substrates:

1. Water-Based, Light-Industrial Coating System: MPI EXT 5.4G (gloss).

a. Prime Coat: Quick-drying primer for aluminum, MPI #95.
b. Intermediate Coat: Water-based, light-industrial coating, MPI #164, gloss matching topcoat.
c. Topcoat: Water-based, light-industrial coating, gloss, MPI #164, MPI gloss level 6.

E. Exterior Gypsum Board Substrates:

1. Latex System MPI EXT 9.2A:

a. Prime Coat: Primer, latex for exterior wood (reduced)[MPI #6].
b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4)[MPI #15].

F. Concrete Pavement, Traffic Surfaces:

1. Traffic-Marking Paint, Latex MPI EXT 3.2E.

a. Topcoat: Traffic-marking paint, latex, MPI #97, white color.

3.8 EXTERIOR COLOR SCHEDULE

A. Reference to a particular manufacturer's number or color name is used only as a convenience for the Owner in order to establish the Project color requirements. These references are not intended to describe the required generic paint systems. For generic paint systems requirements, refer to the "Interior Painting Schedule" as applicable to the respective conditions of use.

B. The selection of paint colors are indicated on the drawings and in the Exterior Finish Schedule by manufacturer and color type; designated as "PT-".

1. Furnish the same lots, batches, etc. within the same contiguous areas of the building (i.e. corridors on the same floors, common rooms which adjoin each other, etc.).

END OF SECTION 099113

SECTION 099123 -- INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Steel.
2. Concrete Unit Masonry
3. Galvanized metal.
4. Wood.
5. Gypsum board.
6. Dry Fall Paint System

B. Related Sections include the following:

1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
2. Division 09 "Exterior Painting."
3. Division 09 painting Section "High-Performance Coatings" for special-use coatings.

C. Paint exposed surfaces, whether or not colors are designated in schedules, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Design Builder will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Architectural woodwork.
b. Acoustical wall panels.
c. Metal toilet enclosures.
d. Metal lockers.
e. Elevator entrance doors and frames.
f. Elevator equipment.
g. Finished mechanical and electrical equipment.
h. Light fixtures.

i. Heating unit enclosures.
j. Switchgear.
k. Distribution Cabinets.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.
b. Furred areas.
c. Ceiling plenums.
d. Utility tunnels.
e. Pipe spaces.
f. Duct shafts.
g. Elevator shafts.

3. Finished metal surfaces include the following:

a. Kynar coated aluminum.
b. Stainless steel.
c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 DEFINITIONS

A. General: Standard painting terms defined in ASTM D 16 apply to this Section.

B. Interior Surfaces: Interior surfaces to be painted are defined as those surfaces which are indicated in areas exposed to conditions which are controlled by building heating and cooling systems.

C. MPI Gloss and Sheen Standards: As follows when tested in accordance with ASTM D 523.

1. Gloss Level 1: A traditional matte finish – flat.

a. Gloss Measured at 60 degrees: Maximum 5 units.
b. Sheen Measured at 85 degrees: Maximum 10 units.

2. Gloss Level 2: A high side sheen flat – velvet.

a. Gloss Measured at 60 degrees: Maximum 10 units.
b. Sheen Measured at 85 degrees: 10 to 35 units.

3. Gloss Level 3: A traditional egg-shell finish.

a. Gloss Measured at 60 degrees: 10 to 25 units.
b. Sheen Measured at 85 degrees: 10 to 35 units.

4. Gloss Level 4: A satin finish.

a. Gloss Measured at 60 degrees: 20 to 35 units.
b. Sheen Measured at 85 degrees: Minimum 35 units.

5. Gloss Level 5: A traditional semi-gloss.

a. Gloss Measured at 60 degrees: 35 to 70 units.

6. Gloss Level 6: A traditional gloss.

a. Gloss Measured at 60 degrees: 70 to 85 units.

7. Gloss Level 7: A high gloss.

a. Gloss Measured at 60 degrees: More than 85 units.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 12-inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Resubmit until required gloss, sheen, color, and texture are achieved.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted. Variation from the "MPI Approved Products List" is not allowed.

1.5 INFORMATION SUBMITTALS

A. Certification: Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Qualification Data: For applicator.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

D. Regulatory Requirements: Provide products that comply with local regulations controlling use of volatile organic compounds (VOCs).

E. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Design Builder will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Wall and Ceiling Surfaces: Provide samples of at least 100-sq. ft.
b. Other Items: Design Builder will designate items or areas required.

2. Apply benchmark samples after permanent lighting and other environmental services have been activated.

3. Final approval of color selections will be based on benchmark samples.

a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Design Builder at no added cost to Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45-deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Protect from freezing.

1.8 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95-deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5-deg F above the dew point; or to damp or wet surfaces.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1-gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers providing products in compliance with requirements include but are not limited to:

1. Behr
2. Benjamin Moore & Co.
3. PPG Architectural Finishes, Inc.
4. Sherwin-Williams Company
5. Or equal.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings and Primers: VOC content of not more than 50-g/L.
2. Nonflat Paints Coatings and Primers: VOC content of not more than 150-g/L.
3. Anticorrosive Coatings: VOC content of not more than 250-g/L.
4. Sealers and Undercoaters: VOC content of not more than 200 g/L.
5. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

6. Restricted Components: Paints and coatings shall not contain any of the following:

    a. Acrolein.
    b. Acrylonitrile.
    c. Antimony.
    d. Benzene.
    e. Butyl benzyl phthalate.
    f. Cadmium.
    g. Di (2-ethylhexyl) phthalate.
    h. Di-n-butyl phthalate.
    i. Di-n-octyl phthalate.
    j. 1,2-dichlorobenzene.
    k. Diethyl phthalate.
    l. Dimethyl phthalate.
    m. Ethylbenzene.
    n. Formaldehyde.
    o. Hexavalent chromium.
    p. Isophorone.
    q. Lead.
    r. Mercury.
    s. Methyl ethyl ketone.
    t. Methyl isobutyl ketone.
    u. Methylene chloride.
    v. Naphthalene.
    w. Toluene (methylbenzene).
    x. 1,1,1-trichloroethane.
    y. Vinyl chloride.

C. Colors: As indicated in Finish Material Legend.

2.3 BLOCK FILLERS

A. Interior Latex Block Filler: MPI #4.

1. Products: Subject to compliance with requirements, provide the following or comparable product from manufacturers listed

    a. Benjamin Moore; Moorcraft, Super Craft Latex Block Filler, 285-01.

    b. Sherwin-Williams; PrepRite, Int./Ext. Block Filler, B25W25.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

1. Products: Subject to compliance with requirements, provide the following or comparable product from manufacturers listed:

   a. Benjamin Moore; Eco Spec WB Interior Latex Primer.
   b. PPG; Speedhide Zero Interior Zero VOC Latex Sealer
   c. Sherwin-Williams; ProMar 200 Zero Primer, Interior Latex Primer, B28W02600/B28WQ2600

B. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.5 METAL PRIMERS

A. Rust-Inhibitive Primer (Water Based): MPI #107.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Benjamin Moore, Ultra Spec HP, Acrylic Metal Primer.
   b. PPG; Pitt-Tech, Pitt-Tech Int/Ext DTM Industrial Primer.
   c. Sherwin-Williams; Pro-Cryl Universal Primer.

2.6 WOOD PRIMERS

A. Interior Latex-Based Wood Primer: MPI #39.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Benjamin Moore; Fresh Start, Multipurpose Latex Primer N023/F023.
   b. PPG; Seal Grip, Interior/Exterior Stain Blocking Primer, 17-921.
   c. Sherwin-Williams; Multi-Purpose Latex Primer/Sealer.

2.7 LATEX PAINTS

A. Institutional Low-Odor/VOC Latex (Flat): MPI #53 (Gloss Level 1) CEILINGS ONLY.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Behr Premium Plus; Interior Flat Paint.
   b. Benjamin Moore; Eco Spec WB Interior Flat Latex Finish.
   c. Sherwin Williams; ProMar 200 Zero VOC Interior Latex Flat.

B. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Benjamin Moore; Ultra Spec 500 Waterborne Interior Low Sheen Finish N537/K537
   b. PPG; Pure Performance Interior Eggshell Latex, 9-300XI
   c. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Eg-Shel.

C. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Benjamin Moore; Ultra Spec 500 Waterborne Interior Gloss N540/K540
   b. PPG Speedhide Zero Interior Zero VOC Latex Semi-Gloss
   c. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Semi-Gloss

2.8 EPOXY COATINGS

A. Water-Based Epoxy (Interior): MPI #115, 139.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Behr Paint; Behr Pro HPC, Pre-Catalyzed WB Epoxy Eggshell.
   b. Cloverdale Paint; Performance Plus; Ecologic Waterborne Epoxy Gloss
   c. Sherwin-Williams; Pro Industrial, Water Based Catalyzed Epoxy,

2.9 DRY FALL PAINT SYSTEM

A. Available Manufacturers: Provide products by one of the following or equal.

1. Glidden Professional
2. Sherwin-Williams Co.
3. PPG

B. Dry Fall Paint System (Ferrous and Non-Ferrous Metals)

Manufacturer	Product
Glidden Professional	Waterborne Interior Eggshell Dry Fall 1482-XXXX
PPG	SpeedHide Super Tech WB Acrylic Dry-Fog
Sherwin-Williams	Waterborne Acrylic Dryfall

1. Surface Preparation: dry fall paints are formulated so that overspray lands as a dry dust after an 8 – 10 foot fall at a temperature of 70° F (20° C). At cooler temperatures (50° F / 10° C) the dry is slowed and the overspray particles may remain wet in the middle.

2. Pulling equipment or walking through the overspray when conditions are cool can cause particles to break open and paint will stick to floor. When using dry fall at temperatures above 70° F (20° C) the dry time is accelerated.

3. Take proper care that paint being applied lands wet on the surface being painted, to ensure good adhesion. Dry fog paint will dry quickly and if paint is partially dry when it contacts the surface, poor adhesion will result.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Use cleaning methods recommended by paint manufacturer. Determine moisture content and alkalinity of surfaces by performing appropriate tests. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Use cleaning methods recommended by paint manufacturer. Determine moisture content and alkalinity of surfaces by

performing appropriate tests. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. Clean using commercial blast cleaning method, and as recommended in writing by paint manufacturer.

1. Commerical Blast Cleaning: Remove all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE No. 3 "Commercial Blast Cleaning."

2. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

G. Galvanized-Metal Substrates: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil, grease, soil, and other coluble contaminants in accordance with SSPC SP-1 "Solvent Cleaning." Pretreat in accordance with the recommendations of SSPC "Good Painting Practice, Vol. 1, Chapter 22."

1. Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

2. If galvanized metal substrates have been passivated or stablilzed, the coating shall be completely removed in accordance with SSPC-SP 7/NACE No. 4 "Brush-Off Blast Cleaning." Galvanized steel to be painted shall not be passivated or stablilized.

H. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
5. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood.
6. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.

7. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

J. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Apply paint in accordance with MPI Painting Manual Premium Grade finish requirements.
2. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
3. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Use applicators and techniques suited for paint and substrate indicated.
6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
7. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
8. Access panels, electrical panels, air diffusing outlets, supply and exhaust grilles, louvers, exposed conduit, primed hardware items, primed outlet covers, primed wall and ceiling plates and other items in painted areas shall be painted to match the areas in which they occur unless otherwise directed by the Design Builder.
9. Finish exterior doors to tops, bottoms, and side edges the same as exterior faces.
10. Sand and dust between each coat to provide an anchor for next coat and to remove visible defects.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under

moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

F. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

G. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

H. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:

1. Mechanical Work:

a. Uninsulated metal piping.
b. Uninsulated plastic piping.
c. Pipe hangers and supports.
d. Tanks that do not have factory-applied final finishes.
e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets. Paint with primer and one coat of matt black (non-reflecting) paint.
f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
g. Mechanical equipment that is indicated to have a factory-primed finish for field painting. Paint to match areas in which they occur, unless otherwise directed by the Design Builder.
h. Backprime and paint face and edges of plywood backing panels for telephone and electrical equipment before installation to match adjacent wall surface.
i. Accessory items.

2. Electrical Work:

a. Switchgear.
b. Panelboards.
c. Electrical equipment that is indicated to have a factory-primed finish for field painting.
d. Conduit and fittings.

I. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

J. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. Provide "Wet Paint" sign to protect newly painted finishes.

C. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

D. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Design Builder, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E (semi-gloss).

a. Prime Coat: Interior/exterior latex block filler, MPI #4.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

A. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S (semi-gloss).

a. Prime Coat: Rust-inhibitive primer (water based), MPI #107.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

2. Water-Based Epoxy Coating System: MPI INT 5.1K

a. Prime Coat: Rust-inhibitive primer (water based), MPI #107.
b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
c. Topcoat: Water-based epoxy (interior and exterior), MPI #115.

B. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N (semi-gloss).

a. Prime Coat: Waterborne galvanized-metal primer, MPI #134.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

2. Water-Based Epoxy Coating System:

a. Prime Coat: Waterborne galvanized-metal primer, MPI #134.
b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
c. Topcoat: Water-based epoxy (interior and exterior), MPI #115.

C. Dressed Lumber Substrates: Including architectural woodwork.

1. Institutional Low-Odor/VOC Latex System: MPI INT 6.3V (semi-gloss).

a. Prime Coat: Interior latex-based wood primer, MPI #39.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

D. Wood Panel Substrates: Including painted plywood.

1. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T (semi-gloss).

a. Prime Coat: Interior latex-based wood primer, MPI #39.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

E. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System: (FLAT CEILINGS ONLY).
a. Primer and two coats.

2. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M (low sheen).

a. Prime Coat: Interior latex primer/sealer, MPI #50.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #144, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, low sheen, MPI #144, MPI gloss level 2.

3. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M (semi-gloss).

a. Prime Coat: Interior latex primer/sealer, MPI #50.
b. Intermediate Coat: Institutional low-odor/VOC interior latex, MPI #147, matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex, semi-gloss, MPI #147, MPI gloss level 5.

4. Water-Based Epoxy Coating System: MPI INT 9.2F

a. Prime Coat: Interior latex primer/sealer, MPI #50.
b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
c. Topcoat: Water-based epoxy (interior and exterior), MPI #115.

3.7 INTERIOR COLOR SCHEDULE

A. The selection of paint colors are indicated on the drawings and in the Finish Material Schedule by manufacturer and color type; designated as "PT-".

1. Furnish the same lots, batches, etc. within the same contiguous areas of the building (i.e. corridors on the same floors, common rooms which adjoin each other, etc.).

END OF SECTION 099123

SECTION 099300 -- INTERIOR CLEAR CONCRETE SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes interior coatings for the following applications:

1. Clear concrete sealants for equipment room floors.

B. Related Sections:

1. Division 01 “Sustainable Design Requirements” for additional requirements.
2. Division 03 “Cast-in-Place Concrete” for concrete finishes.

1.3 ACTION SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show extent of each coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors, textures, and patterns available for each type of product indicated.

1.4 INFORMATION SUBMITTALS

A. Qualification Data: For Installer.

B. Material Test Reports: For each coating.

C. Material Certificates: For each coating, signed by manufacturers.

D. Field quality-control test reports.

E. Warranty: provide sample manufacturer's warranty.

F. Maintenance Data: For coatings to include in maintenance manuals. Identify substrates and types of coatings applied. Include recommendations for periodic inspections, cleaning, care, maintenance, and repair of coatings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of coatings required for this Project.

B. Source Limitations:

1. Obtain coatings from a single manufacturer.

C. Concrete:

1. Appropriate wet curing procedure should be used on the concrete.
2. Control joints to be in accordance with pertinent ACI and PCA standards.
3. Integrally cast drain flanges into and flush with concrete deck surfaces that slope to drain.

D. Fire-Test-Response Characteristics: Provide coating materials with the fire-test-response characteristics as determined by testing identical products per test method below for deck type and slopes indicated by an independent testing and inspecting agency.

E. First-installed work mockups: Apply mockups to set quality standards for materials and execution.

1. Design Professional will select one representative surface for coating and substrate to receive coatings. Apply coating to at least 200 sq. ft. each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
2. Approved mockups may become part of the completed Work if undisturbed at time of Material Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:

1. Manufacturer's brand name.
2. Type of material.
3. Directions for storage.
4. Date of manufacture and shelf life.
5. Lot or batch number.
6. Mixing and application instructions.

B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Apply coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.

B. Do not install coating until items that will penetrate membrane have been installed.

1.8 WARRANTY

A. Warranty: Manufacturer's standard warranty:

1. Term: three years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material Compatibility: Provide materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.2 INTERIOR CLEAR CONCRETE SEALANTS AND DENSIFIERS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: available products include the following or equal:

   a. Curecrete Distribution; Ashford Formula.
   b. Edoco by Dayton Superior; Sure Hard Densifier J17.
   c. Euclid Chemical; Eucoseal.

2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Physical Properties:

1. Specific Gravity: 1.2
2. Flash Point: None
3. Depth of Penetration: As much as 5mm into concrete
4. Water Absorption (ASTM C-642): After 48 hour immersion, 19.7% improvement over untreated control specimens
5. Compressive Strength (ASTM C-109):
6. Water Vapor Transmission Rate ASTM F 1869: 5.00 lbs/ 1,000 sqft/ 24 hours, 31% improvement over untreated control specimens
7. Taber Abrasion (ASTM C501): 16.5% improvement over untreated control specimens
8. Dynamic coefficient of friction (ANSI A137.1 Slip Resistance): Concrete substrate: 0.52; after densifier was applied: 0.54.
   a. Meets ANSI A137.1 (DCOF) of 0.42 or greater

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of coatings.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
2. Verify compatibility with and suitability of substrates.
3. Begin coating application only after minimum concrete curing and drying period recommended by coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
4. Verify that substrates are visibly dry and free of moisture.

    a. Test for moisture content by method recommended in writing by manufacturer.

5. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for coating application.

B. Mask adjoining surfaces not receiving coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.

C. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
2. Remove concrete fins, ridges, and other projections.
3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.3 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

3.4 COATING APPLICATION

A. Apply coating material according to ASTM C 1127 and manufacturer's written recommendations.

1. Start coating application in presence of manufacturer's technical representative.

2. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft..

B. Apply coatings to prepared wall terminations and vertical surfaces to height indicated, and omit aggregate on vertical surfaces.

C. Cure coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

3.5 PROTECTING AND CLEANING

A. Protect coatings from damage and wear during remainder of construction period.

B. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 099300

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. High Performance Coatings:

   a. Surface preparation and field application of high performance systems to substrates subject to weather, wear and abuse.
   b. Substrates include:

      1) Exterior exposed steel.

2. Duplex Coatings on Galvanized steel – locations as indicated on drawings.

3. Interior High Performance Coatings – Monumental Atrium Stair.

B. Related Sections:

1. Division 05 Section “Shop Applied Primers” for primers for exposed structural and galvanized structural steel.
2. Division 05 Section “Structural Steel Framing” for galvanizing requirements.
3. Division 09 “Gypsum Board Assemblies.”
4. Division 09 “Resinous Flooring.”

1.3 ACTION SUBMITTALS

A. Product Data: For each coating system indicated.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, Architect will furnish color chips for surfaces to be coated.

C. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.

3. Submit samples on the following substrates for Architect's review of color and texture:

a. Ferrous and Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.

1.4 INFORMATION SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator that has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are

protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95 degrees F.

B. Do not apply coatings in rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Provide products by one of the following manufacturers or equal:

1. AkzoNobel International; Devoe High Performance Coatings
2. Carboline Coatings
3. PPG
4. Tnemec

2.2 HIGH PERFORMANCE COATING SYSTEM AT EXTERIOR EXPOSED STEEL

A. System Description: One finish coat over an intermediate coat and a primer.

1. Shop Primer: Refer to Division 05 “Shop Applied Primers” for requirements.

2. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
   a. Carboline: 134 HG 2-Component Epoxy.
   b. Tnemec: 1074 Endura-Shield II Acrylic Urethane

3. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   a. Devoe: Devthane 379 UVA Aliphatic Urethane Gloss Enamel.

4. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   a. Carboline: 134-HG 2-Component Acrylic-Aliphatic Urethane.

b. Devoe: Devthane 379 UVA Aliphatic Urethane Clear Gloss Enamel.
c. Tnemec: 1074 Endura-Shield II Acrylic Urethane

B. Colors: Custom colors selected by Architect.

2.3 DUPLEX COATING SYSTEM AT EXTERIOR EXPOSED STEEL

A. (Basis of Design) Manufacturer: Tnemec products form the basis of specification below. Provide the following or equal.

B. System Description: Two coat system over galvanized steel.

1. Shop Primer: Refer to Division 05 “Shop Applied Primers” for requirements for hot dipped galvanized coatings as primers.
   a. Surface Preparation: Prepare Hot dipped galvanized in accordance with SSPC-SP16.

2. Shop applied prime coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 4.0 mils DFT.
   a. Tnemec: Series 161HS polyamide epoxy applied at a dry film thickness of 3.0 to 4.0 mils DFT

3. Field Touch Up Welds and Abrasions: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 4.0 mils DFT.
   a. Tnemec: Series 161HS polyamide epoxy applied at a dry film thickness of 3.0 to 4.0 mils DFT

4. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 4.0 mils DFT
   a. Tnemec: Series 1074U Endura-Shield II Acrylic Urethane applied at a dry film thickness of 2.0-4.0 mils DFT

C. Colors: Custom colors selected by Architect.

2.4 INTERIOR HIGH-PERFORMANCE COATINGS – STEEL

A. Water-Based Epoxy (Interior): MPI #115, 139.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

   a. Behr Paint; Behr Pro HPC, Pre-Catalyzed WB Epoxy Eggshell.
   b. Cloverdale Paint; Performance Plus; Ecologic Waterborne Epoxy Gloss
   c. Sherwin-Williams; Pro Industrial, Water Based Catalyzed Epoxy,

PART 3 - EXECUTION

3.1 EXAMINATION

A. General: With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.
b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.2 PREPARATION - GENERAL

A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

B. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

C. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Ferrous-Metal Substrates: Clean ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use leaning methods that comply with SSPC recommendations as follows.

a. Surface Preparation: SP-6.

D. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 PERPARATION FOR DUPLEX COATINGS

A. Brush Off or Sweep Blasting: Prepare galvanized steel surfaces to receive duplex coatings using a brush-off abrasive blast clean, also known as a sweep blast, according to the requirements of “SSPC-SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals” and as follows:

1. Performance Requirements: Finish surface shall have a minimum profile of 0.75 mils over the entire surface. Operator shall avoid removing excessive amounts of zine and shall not remove more than 1 mil of galvanized coating.

    a. Use rapid nozzle movement
    b. Maintain an overall work-rate of 1200 ft2/hr or greater
    c. Choose an appropriate blasting medium
    d. Select blast pressure based on abrasive medium, nozzle to work distance, and geometry of the piece
    e. Use clean, un-contaminated compressed air.
    f. Maintain temperature of the substrate at 5°F or higher than the dew point
    g. After blasting, blow down surface with clean compressed air
    h. Apply paint or powder coating as soon as possible after blasting

3.4 APPLICATION

A. Apply shop primer to all steel members except galvanized. Refer to Division 05 “Shop Applied Primers” for requirements.

B. General: Apply high-performance coatings according to manufacturer's written instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
4. Provide finish coats compatible with primers used.

C. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

D. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

E. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.5 FIELD QUALITY CONTROL

A. University reserves the right to invoke the following procedure at any time and as often as University deems necessary during the period when coatings are being applied:

1. University may engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will perform appropriate tests for the following characteristics as required by University:

   a. Quantitative materials analysis.
   b. Absorption.
   c. Accelerated weathering.
   d. Accelerated yellowness.
   e. Color retention.
   f. Alkali and mildew resistance.
   g. Abrasion resistance.
   h. Apparent reflectivity.
   i. Washability.
   j. Dry opacity.
   k. Recoating.
   l. Skinning.

3. University's Representative may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

3.6 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.7 PROTECTION

A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

END OF SECTION 099600

SECTION 101100 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. ~~Porcelain enamel and glass markerboards~~ **Visual Display Surfaces**.

B. Related Sections:

1. Section 115213 "Projection Screens" for VDS03.

1.3 SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated. Include manufacturer’s specifications, product handling and storage recommendations, and installation instructions.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Show location of panel joints.
2. Include sections of typical trim members.

D. Samples for Verification: For each type of visual display surface indicated and as follows:

1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.

E. Maintenance Data: For visual display surfaces to include in maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display units vertically with packing materials between each unit.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating visual display surfaces without field measurements. Coordinate wall construction to ensure that actual dimensions correspond to established dimensions.

1.7 WARRANTY

A. Special Warranty for Porcelain-Enamel Writing Surface: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Surfaces lose original writing and erasing qualities.
b. Surfaces exhibit crazing, cracking, or flaking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers providing products include the following or equal:

1. Clarus
2. Steelcase.

2.2 VDS01: PROJECTABLE BOARD

A. (Basis of Design) Clarus "View Projection Glass."

B. Characteristics:

1. **Writing surface with lights on.**
2. **High definition projection surface with lights off.**

C. Physical Properties:

1. **6 mm tempered safety writing glass.**
2. **Starphire glass for projectable writing surface.**
3. **Finish: Clarus View White**
4. **Surround 3.0: Ultra-thin frame for seamless writing plane.**
5. **Dimensions: Refer to Visual Displace Surface Schedule on the Drawings.**

2.3 VDS02: MARKER BOARD

A. (Basis of Design) Clarus "Clarus Float."

B. Characteristics:

1. **Glass markerboards.**

C. Physical Properties:

1. **1/4" Clarus tempered safety glass.**
2. **Non-staining writing surface.**
3. **Compatible with any marker including permanent.**
4. **Opti-clear polish and eased corners for safety.**
5. **Mounting style: Float**
   a. **Concealed mounting hardware and anchors.**

2.4 VDS03: Refer to Division 10 "Projection Screens."

2.5 VDS04 and VDS05: MARKER AND TACK BOARD SYSTEMS

A. (Basis of Design) Steelcase "EMEA-H.SYSTEM." Refer to Schedule on the drawings for dimensions and configurations.

B. Characteristics:

1. **Fixed and moveable Tack boards.**

C. Physical Properties:

1. **H System: Wall Mounted rail system.**
   a. **2 Layers.**
   b. **Modular Construction.**

~~2.1~~2.6 VDS06: MAGNETIC GLASS MARKER BOARD

A. (Basis of Design) Clarus "Wall-to-Wall."

B. Characteristics:

1. Magnetic Glass

C. Physical Properties:

1. 1/4" tempered safety writing glass.
2. Non-staining writing surface.
3. Compatible with any marker including permanent.
4. Opti-clear polish and eased corners for safety.

2.7 VDS07: TACKABLE BOARD

A. (Basis of Design) Steelcase "Edge" Writing and Tack Boards: Refer to Schedule on the drawings for dimensions.

B. Characteristics:

1. White writing surface.
2. Trim and marker tray.

2.8 VDS08: SLIDING MARKER BOARD

A. (Basis of Design) Clarus "Glide." Refer to Schedule on the drawings for dimensions.

B. Characteristics:

1. Sliding Glass Boards.

C. Physical Properties:

1. 1/4″ Clarus tempered safety writing glass
2. Available in Starphire (gloss) or Silk (matte) finish
3. Non-staining writing surface
4. Magnetic
5. Clarus Opti-Clear finish and eased corners for safety

2.9 VDS09: FIXED PROJECTABLE BOARD

A. (Basis of Design) Clarus "Glide." Refer to Schedule on the drawings for dimensions.

B. Characteristics:

1. Fixed Projectable Glass Boards.

~~2.2~~2.10 MARKERBOARD AND TACKBOARD ACCESSORIES

A. Manufacturers Accessories: Provide as recommended for each type of visual display.

~~A.~~**B.** Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; of size and shape indicated.

1. Factory-Applied Trim: Manufacturer's standard.

~~B.~~**C.** Marker tray: Manufacturer's standard, continuous.

1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

~~2.3~~2.11 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Visual Display Boards: Factory assemble visual display boards, unless otherwise indicated.

1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.

C. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
2. Provide manufacturer's standard vertical-joint spline system between abutting sections of markerboards.
3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.

1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

~~2.4~~2.12 ALUMINUM FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Powder-Coat Finish: Apply manufacturer's standard baked finish, complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance.

B. Examine walls and partitions for proper backing for visual display surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
   1. Mounting Height: 36 inches above finished floor to top of chalktray.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

3.5 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100

SECTION 101470 -- FIRE RESISTANCE ASSEMBLY IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following fire resistance assembly identification materials and their installation:

1. Fire resistance rated partition markers.
2. Ceiling access panel and door markers.
3. Stencils.

B. Related Sections include the following:

1. See Division 10 Section "Signage" for panel signs and dimensional characters.

1.3 SUBMITTALS

A. Product Data: Include material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. Shop Drawings: Floor plans or reflected ceiling plans drawn to scale and showing proposed location of identification devices and coordinating with penetrations through partitions, piping, ductwork, and other construction.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each identification device through one source from a single manufacturer.

B. Regulatory Requirements: Provide identification devices that comply with the ICC International Building Code, 2012 Edition with Georgia Amendments..

C. Comply with 29 CFR 1910.145, "Specifications for Accident Prevention Signs and Tags."

D. Comply with ANSI Z53.1, "Safety Color Code for Marking Physical Hazards and the Identification of Certain Equipment."

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of ceiling access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 FIRE RESISTANCE ASSEMBLY IDENTIFICATION DEVICES

A. Fire Resistance Rated Partition Markers: 1/16-inch thick, engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: To match the fire resistance rating of the partition, as follows:

a. "ONE HOUR FIRE RATED PARTITION."

b. "TWO HOUR FIRE RATED PARTITION."

2. Letter Color: Red, complying with ANSI Z53.1.

3. Background Color: White, complying with ANSI Z53.1.

B. Access Panel and Door Markers: 1/16-inch thick, engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: To match the fire resistance rating of the partition to which the access panel or door provides access, as follows:

a. "ONE HOUR FIRE RATED PARTITION."

b. "TWO HOUR FIRE RATED PARTITION."

2. Letter Color: Red, complying with ANSI Z53.1.

3. Background Color: White, complying with ANSI Z53.1.

2.2 STENCILS

A. Stencils: Prepared with minimum letter height of 1 inch fire resistance rated partition markers and access panel and door markers.

1. Stencil Material: Metal or fiberboard.

2. Stencil Paint (For Letters): Exterior, gloss, acrylic enamel, red, unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint (For Background): Exterior, acrylic enamel, white, unless otherwise indicated.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.

B. Adhesive: Adhesive recommended for directly adhering identification devices to continuous substrate.

1. Use adhesives that have a VOC content of 80-g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in Division 09 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 FIRE RESISTANCE ASSEMBLY IDENTIFICATION

A. Install fire resistance rated partition markers with permanent adhesive on each fire resistance rated partition above the finished ceiling and below access flooring.

1. Letter Size: Minimum 1 inch high. Provide all upper case letters.

2. Include markers for the following general categories of fire resistance rated partitions:

a. Fire walls.
b. Vertical fire separation assemblies.
c. Fire partitions.
d. Smoke barriers.

3. Locate markers where accessible and visible above the finished ceiling, below access flooring, and as follows:

a. Near each ceiling access panel and door.
b. Spaced at maximum intervals of 8 feet on center along each fire resistance rated partition.
c. Located on both sides of each fire resistance rated partition.
d. Where there is no finished ceiling in mechanical and maintenance spaces, locate markers at least 9-feet above the finished floor.

B. Install ceiling access panel and door markers on the inside of the panels and doors with permanent adhesive on each ceiling access panel and door that provides access to fire resistance rated partitions.

1. Letter Size: Minimum 1-inch high. Provide all upper case letters.
2. Locate markers where accessible and visible on the inside of the ceiling access panels and doors.

C. Stenciled Marker Option: Stenciled markers may be provided instead of laminated-plastic markers, at Installer's option. Install stenciled markers on each fire resistance rated partition and ceiling access panel and door.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for letters marking.

3.3 ADJUSTING

A. Relocate identification materials and devices that have become visually blocked by other work.

3.4 CLEANING

A. Clean faces of identification devices.

END OF SECTION 101470

SECTION 102100 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes toilet compartments and screens as follows:

1. Type: Solid Color Reinforced Composite
2. Compartment Style: Floor to Ceiling Mounted.
3. Screen Style: Wall mounted.

1.3 PERFORMANCE REQUIREMENTS

A. Solid Color Reinforced Composite panels shall be tested according to ASTM E 84-01 “Test for Surface Burning characteristics of Building Materials” and shall meet the a minimum of the following (Class B Fire Rating):

1. Flame spread: < 45.
2. Smoke Development: < 450.

1.4 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type and style of toilet compartment and screen specified. Include details of construction relative to materials, fabrication, and installation. Include details of anchors, hardware, and fastenings.

C. Shop Drawings: For fabrication and installation of toilet compartment and screen assemblies. Include plans, elevations, sections, details, and attachments to other work.

1. Show locations of reinforcement and cutouts for compartment-mounted toilet accessories.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors, textures, and patterns available for each type of compartment or screen indicated.

E. Samples for Verification: Of each compartment or screen color and finish required, prepared on 6-inch- square Samples of same thickness and material indicated for Work.

F. Preparation/Field Verification:

1. Prior to installation of wall finishes, verify required blocking has been installed in proper locations.
2. Proceed with installation of items only after unsatisfactory conditions have been corrected. Installation of items indicates all conditions are satisfactory.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 SOLID COLOR REINFORCED COMPOSITE (SCRC) TOILET COMPARTMENTS

A. Acceptable Manufacturers and Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are the following or equal:

1. (Basis of Design) Bobrick Washroom Equipment, Inc; Bobrick SierraSeries.
2. Bradley Corporation; Mills Partitions
3. Scranton

B. Toilet-Enclosure Style: Floor to ceiling mounted.

C. Urinal-Screen Style: Wall mounted.

D. Pilaster Shoes: Fabricated from stainless-steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

E. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.2 MATERIALS

A. Materials: Solid color reinforced composite (SCRC) material for stiles, panels, doors, and screens with (Basis of Design) Bobrick “GraffitiOff” coating or equal, thermoset and integrally fused into homogenous piece

1. High density polyethylene (HDPE), high density polypropylene not acceptable.
2. Composition: Dyes, organic fibrous material, and polycarbonate/phenolic resins.
3. Surface Treatment: Non-ghosting, graffiti resistant surface integrally bonded to core through a manufacturing steps requiring thermal and mechanical pressure.
4. Edges: Same color as the surface.
5. Color: As selected by Architect from manufacturer's standard SierraSeries range.

B. Performance Requirements
1. Graffiti Resistance (ASTM D 6578): Passed cleanability test; 5 staining agents.
2. Scratch Resistance (ASTM D 2197): Maximum load value exceeds 10 kilograms.

3. Impact Resistance (ASTM D 2794): Maximum impact force exceeds 30 inch-pounds.
4. Smoke Developed Index (ASTM E 84): Less than 450.
5. Flame Spread Index (ASTM E 84): Less than 75.
6. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B.
7. Uniform Building Code: Class II.

C. Finished Thickness:
1. Stiles and Doors: 3/4 inch (19 mm).
2. Panels and Screens: 1/2 inch (13 mm).

D. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods.

E. Leveling Devices: 7 gauge, 3/16 inches (5 mm) thick, corrosion-resistant, chromate-treated, double zinc-plated steel angle leveling bar bolted to stile; furnished with 3/8 inch (10 mm) diameter threaded rods, hex nuts, lock washers, flat washers, spacer sleeves, expansion anchors, and shoe retainers.

F. Stile Shoes: One-piece, 22 gauge (0.8 mm), 18-8, Type 304 stainless steel, 4 inch (102 mm) height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch (19 mm) or 1 inch (25 mm) stile thickness and capable of being fastened (by clip) to stiles starting at wall line.

G. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge (1.6 mm) stainless steel with satin finish; 1 inch (25 mm) x 1-1/2 inches (38 mm) x 58 inches high (1473 mm).

H. Anchors: Expansion shields and threaded rods at floor connections as applicable. Threaded rods secured to supports above ceiling as applicable. Supports above ceiling furnished and installed as Work of Section 05 50 00 - Metal Fabrications.

I. Hardware: Chrome-plated "Zamak", aluminum, extruded plastic hardware not acceptable.

1. Compliance: Operating force of less than 5 lb (2.25 kg).
2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish.
4. Doorstops: Prevents inswinging doors from swinging out beyond stile; on outswing doors, doorstop prevents door from swinging in beyond stile.
5. Fastening: Hardware secured to door and stile by through-bolted, theft-resistant, pin-in-head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners secured directly into core not acceptable.
   a. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lb (680 kg) per insert.
6. Clothes Hooks: Projecting no more than 1-1/8 inch (29 mm) from face of door.
7. Door Latch: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 16 gauge (1.6 mm) sliding door latch, 14 gauge (2 mm) keeper.
8. Locking: Door locked from inside by sliding door latch into keeper.
9. Hinge Type:
   a. Standard.
      1) Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.
   b. Full-Height Institutional Hinge.
      1) Hinges: 16 gauge (1.6 mm) stainless steel, self-closing, 3 section hinges.
10. Mounting Brackets:

a. Standard Concealed.
   1) Mounting Brackets: Mounted inside compartment; exposed brackets on exterior of compartment not acceptable with the exception of outswing doors.
b. Full-Height.
   1) Mounting Brackets: 18 gauge (1.2 mm) stainless steel and extend full height of panel.
   2) U-Channels: Secure panels to stiles.
   3) Angle Brackets: Secure stiles-to-walls and panels to walls.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

   1. Material: Stainless steel.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Floor Mounted, Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Doors: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments indicated to be accessible to people with disabilities.

   1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
   2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
   3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
   4. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

C. Wall-Hung Screens: Provide units in sizes indicated of same construction and finish as compartment panels.

   1. Provide screens with full-height continuous, clear anodized aluminum brackets for attachment to wall.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Provide all items and accessories as required for a total and complete installation in every respect.
2. Install units level, plumb and true, firmly anchored in locations and heights indicated.
3. Install grab bars, each to withstand a separate bending stress, shear stress, shear force and tensile force of 250 lb-f.
4. Adjust and lubricate hardware according to manufacturer’s written instructions.

B. Floor-Anchored Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ADJUSTING AND CLEANING

A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

B. Cleaning: Clean exposed surfaces in accordance with manufacturer’s instructions and recommendations.

3.3 PROTECTION DURING CONSTRUCTION

A. Provide proper protection of compartments and screens after installation. Replace items that are damaged or do not comply with requirements.

END OF SECTION 102100

SECTION 102600 – WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following as indicated on the drawings.

1. Vinyl corner guards.
2. Stainless steel corner guards.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.

B. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Wall Guards: 12-inch- long samples of rail and mounting bracket. Include examples of joinery, corners, and field splices. Show end radius.
2. Corner Guards: 12-inch- long samples of stainless steel corner guards.
3. Jamb Guards: 12-inch- long samples of guard and mounting bracket.

D. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.

1. Include recommended methods and frequency of maintenance for maintaining optimum condition of rigid sheet wall protection under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

E. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Fire-Test-Response Characteristics: Provide impact-resistant wall protection system components with the following surface-burning characteristics, as determined by testing materials identical to those required in this Section per ASTM E 84 by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify impact-resistant wall protection system components with appropriate markings of applicable testing and inspecting agency.

1. Flame Spread: 25 or less.
2. Smoke Developed: 450 or less.

E. Impact Strength: Provide assembled wall protection units that have been tested in accordance with the applicable provisions of ASTM F476.

F. For Wall Panels - Color match: Provide wall protection components that are computer controlled within manufacturing tolerances and typical limitations of digital printing color matching.

G. Pre-installation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Keep vinyl/acrylic sheet material out of direct sunlight.
2. Store wall protection components for a minimum of 72 hours, or until material attains a minimum room temperature of 70 deg F.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install wall surface-protection system components until the space is enclosed and weatherproof and ambient temperature within the building is maintained at not less than 70 deg F for not less than 72 hours before beginning installation.

B. Field Measurements:

1. Prior to taking field dimensions, representative of manufacturer to visit site, evaluate the conditions, and report any conditions that prohibit the initiation of field measurements.
2. Permanent walls and door bucks must be in place. All cutouts in wall at level of railing installation, such as electric, plumbing and service panels, air handling vents, and fire alarm boxes, must be located and indicated on field measurements so as not to be covered by wall guard.
3. All measurements to be taken on site by authorized representative of manufacturer.
4. Field measurements must be taken to +/- 1/8 inch, and are to be taken level against the wall surface at the elevation at which the wall guard is to be installed.

1.7 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Deterioration of vinyl/acrylic and other materials beyond normal use.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. To be verified with GSK. Typical: full-size equal to 2 percent of each type, color, and texture of units installed, but no fewer than two units.

B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
1. Arden Architectural Specialties, Inc.
2. C/S Group (Construction Specialties, Inc.)
3. Korogard Wall Protection Systems
4. IPC Door and Wall Protection Systems, Inc.

2.2 CORNER GUARDS

A. **CG1:** Adhesive applied Stainless Steel Corner Guards: Fabricated from one-piece, formed or extruded metal with formed edges; with 90- degree turn to match wall condition.3. Finish: #4 Satin.

1. Product and materials: Stainless steel, Type 304.
2. Thickness: Minimum 16 gauge.
3. Finish: Directional satin, No. 4.
4. Width (Leg length): 2 1/2" X 2 1/2"
5. Height: 60 inches (splices not acceptable)
6. Angle: 90°
7. Corner radius: 1/8 inch
8. Mounting: Adhesive

B. **CG2**: Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with turn angle to match wall condition.

1. Cover: Extruded rigid plastic, minimum 0.100-inch wall thickness.

2. Retainer: Minimum 0.060-inch- thick, 1-piece, extruded aluminum.
3. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
4. End wall corner guard assembly to match.

C. Apply sealant as specified in Division 07 "Joint Sealants" to seal all gaps between Corner Guards and walls.

2.3 MATERIALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M.

B. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.

C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

D. Adhesive: As recommended by impact-resistant wall protection manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 METAL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Remove tool and die marks and stretch lines, or blend into finish.
2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
3. Run grain of directional finishes with long dimension of each piece.
4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.

1. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
2. For impact-resistant wall-protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

C. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer's installation instructions.

3.3 INSTALLATION

A. General: Install corner guards and impact-resistant wall protection units, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished work.

3.4 CLEANING AND PROTECTION

A. Immediately after completion of installation, clean rigid wall protection and accessories using a cleaning agent recommended in writing by manufacturer.

B. Remove excess adhesive and sealants using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Warm air dryers.
4. Childcare accessories.
5. Underlavatory guards.
6. Custodial accessories

B. Related Sections:

1. Division 08 Section "Mirrors" for frameless mirrors.
2. Division 10 Section "Toilet Compartments".
3. Division 22 "Plumbing" sections for plumbing requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated on Drawings.
2. Identify products using designations indicated on Drawings.

1.4 INFORMATION SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Architect.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.8 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.

C. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

D. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Basis-of-Design Product: The design for accessories is based on products indicated on the drawings. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Koala Kare Products
7. Tubular Specialties Manufacturing, Inc.

~~7.~~B. For Toilet Accessories, tags, manufacturers and model numbers, refer to Toilet Accessory Schedule on the Drawings.

2.3 WARM-AIR DRYERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Excel Dryer Corporation.
2. Dyson.

B. Warm-Air Dryer:

1. Mounting: Surface mounted.
2. Operation: Electronic-sensor activated with timed power cut-off switch.
3. Cover Material and Finish: selected by Architect, approved by FPU PM
4. Electrical Requirements: Verify with manufacturer

2.4 CHILDCARE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Specialties, Inc.
2. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
3. Koala Kare Products; a division of Bobrick Washroom Equipment, Inc.

B. Diaper-Changing Station:

1. Basis-of-Design Product: GAMCO BCS-2.
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
3. Engineered to support a minimum of 250-lb static load when opened.
4. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed Operation: By pneumatic shock-absorbing mechanism.

5. Material and Finish: HDPE in manufacturer's standard grey color
6. Liner Dispenser: Built in.

2.5 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Plumberex Specialty Products, Inc.
2. Truebro by IPS Corporation.
3. Underlavatory Guard :

B. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.

C. Material and Finish: Antimicrobial, molded plastic, white.

2.6 CUSTODIAL ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

B. Utility Shelf:

1. Description: With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
2. Size: 16 inches long by 6 inches deep.
3. Material and Finish: Not less than nominal 0.05-inch- thick stainless steel, No. 4 finish (satin).

C. Mop and Broom Holder:

1. Basis-of-Design Product: B-224.
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches.
4. Hooks: Three.
5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, No. 4 finish (satin).
   a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
   b. Rod: Approximately 1/4-inch- diameter stainless steel.

D. Paper Towel (Roll) Dispenser, Provide one per custodial closet.

E. Liquid-Soap Dispenser, provide one per custodial closet.

2.7 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to University representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

SECTION 104116 – EMERGENCY KEY STORAGE CABINET

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Emergency Key Storage Cabinet - Fire Department Key Box.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire department key box. Include manufacturer's specifications and installation instructions for unit built-in or connected to other construction.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Include adjustments to designed wall thicknesses necessary for proper installation.

C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1. Operation and Maintenance Data: For fire department key box to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with local fire department regulations for fire department key box.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire department key box wrapped and crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Deliver keys to Owner by registered mail or overnight package service.

1.6 COORDINATION

A. Coordinate installation of anchorages for fire department key box. Furnish directions for installing anchorages, including recessed mounting kits with integral anchors, anchor bolts, and other items, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following or equal.

1. **FS01** - (Basis of Design) Knox-Box 3200 Series with Hinged Door, High Security Commercial Key Box, with 3200 Recessed Mounting Kit (RMK); Knox Company.

2. Acceptable manufacturers include:

   a. Allegion; Falcon Key Control System and 9-1-1 box.
   b. Kidde; “SupraSafe Rapid Entry System”.

2.2 MATERIALS

A. Steel Plate, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

C. Stainless-Steel Sheet: ASTM A 666, Type 304.

2.3 DOOR AND BOX ASSEMBLY

A. Door: Fabricated from all-welded, 1/2 inch thick steel plate construction with interior gasket seal.

B. Recessed Box Housing: Fabricated from all-welded, 1/4 inch thick steel plate construction, with jambs, head, and sill, shaped to receive door. Provide fully welded flange on all sides of box housing for a recessed installation. Provide anchorage at rear of box housing for a secure and vandal resistant installation.

C. Size: Door and box assembly shall be approximately 3-1/4 inches deep and large enough to hold 10 keys or access cards in the interior compartment.

D. Finish: Manufacturer's standard factory-applied powder coat finish, applied to door, box housing, and wall flanges.

1. Color: As selected by Architect from manufacturer's full range.

2.4 HARDWARE AND ACCESSORIES

A. Hinges: Manufacturer's recommend security hinge fully welded to door and box housing for a secure and vandal resistant installation.

B. Lock: Manufacturer's recommended UL listed security lock.

1. Provide 1/8 inch thick stainless steel hinged cover plate with tamper seal for protection of lock case and locking mechanism.

C. Recessed Mounting Kit: Provide manufacturer's recommended shell housing and mounting hardware for masonry construction. Fire department key box shall fit inside of shell housing. Shell housing shall be fabricated from all welded steel plate construction with reinforcing bars that tie into wall and studs mounted to anchor the fire department key box.

2.5 FABRICATION

A. Fabricate fire department key box rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

B. Factory install fire department key box hardware.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and so surfaces are free of oil and other contaminants.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate size and location of fire department key box indicated to be recessed into masonry, and furnish anchoring devices with diagrams and instructions for their installation.

3.3 INSTALLATION

A. Install recessed shell housing accurately in position and securely anchor into stone-clad masonry wall according to manufacturer's written instructions.

B. Set fire department key box accurately in position; plumbed, aligned, and anchored securely to recessed shell housing; according to manufacturer's written instructions. Embed exposed flanges of box housing in sealant against the exterior masonry wall.

3.4 ADJUSTING AND CLEANING

A. Adjust hardware for proper operation.

B. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 104116

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Portable fire extinguishers.

2. Fire-protection cabinets for the following:

   a. Portable fire extinguishers.
   b. Portable fire extinguisher, fire hose, and fire hose valve.

3. Mounting brackets for fire extinguishers.

1.3 SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.

1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
2. Show location of knockouts for hose valves.

C. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Initial Selection: For each type of fire protection cabinet indicated.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Size: 6 by 6 inches square.

F. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

G. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

H. Samples for Initial Selection

1.4 QUALITY ASSURANCE - FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

A. General: All portable fire extinguishers and non-valved cabinets shall be furnished and installed by the General Contractor. All portable fire extinguishers and components shall conform to National Fire Protection Association (NFPA) Pamphlet 10, latest edition. Each extinguisher shall be approved by Underwriter's Laboratory (UL) and bear their label.

B. Approvals: The selection and locations of the fire extinguishers are subject to the review and approval of the University Project Manager and designated University personnel from the Division of Environmental Health and Safety. Extinguishers meeting the described requirements, including those manufactured by Amerex or Buckeye will be considered for acceptance.

C. Selection and Quantity: Refer to NFPA Pamphlet 10, Chapters 2, 3, and 4. Chapter 2 is used to determine the classification of potential fires and the rating or relative fire extinguishing effectiveness of various types of extinguishers. Chapter 3 assists in selection of extinguishers which is dependent upon the character of anticipated fires, property construction and occupancy, the vehicle or hazard to be protected, ambient temperature conditions, and other factors. The quantity of extinguisher is determined by Chapter 4.

D. Caution: Penetration of walls by cabinets or other penetrations, unless openings and voids are sealed with fireproof materials, is prohibited. Fire-rated walls must not have the rating reduced by penetrations or reduction of thickness.

E. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

F. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

G. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

H. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

C. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.6 SEQUENCING

A. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. General: Provide visual identification signage per Florida Code.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amerex Corporation
2. Ansul
~~2.~~**3.** Buckeye
~~3.~~**4.** Potter Roemer; Div. of Smith Industries, Inc.
~~4.~~**5.** Or equal.

C. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Valves: Manufacturer's standard.
2. Handles and Levers: Manufacturer's standard.
3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

~~3.~~D. FIRE EXTINGUISHER TYPES:

~~D.~~**1.** Multipurpose Dry-Chemical Type: UL-rated 4-A:80-B:C, 5-lb nominal capacity, in enameled-steel container.
2. Class “K” – Food and Catering Kitchens: UL Rated 2A:K, 2.5 gallon capacity.
3. Clean-Agent Type in Steel Container: with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

a. At each Data Room, provide the following or equal:
1) Ansul CLEANGUARD Clean Agent Extinguishers
b. Rated for Class A, B, and C fires.
c. Agent: HFC-236fa is a colorless, odorless, electrically non-conductive ‘‘clean’’ agent which discharges as a liquid and flashes to a gas, providing an increased effective firefighting range. HFC-236fa will not cause thermal shock damage to delicate electronic equipment.
~~E.~~d. Rechargeable.

2.2 FIRE PROTECTION CABINETS

A. General: Provide visual identification signage per Florida Code.

B. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.

1. JL Industries, Inc.
2. Basis of Design: Larsen’s Manufacturing Company.
3. Potter Roemer; Div. of Smith Industries, Inc.
4. Or equal

2.3 FIRE-PROTECTION CABINETS

A. Fully Recessed_FEC01:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

   a. Larsen's Manufacturing Company; Model 2409-R1 or equal.

2. Cabinet Construction: Manufacturer's standard enameled steel box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style shown suitable for Owner furnished fire extinguisher. Weld all joints and grind smooth. Miter and weld perimeter door frames.
3. Construct cabinets with double walls fabricated from 0.0428-inch thick, cold-rolled steel sheet. At fire rated cabinets, line double walls with minimum 5/8-inch thick, fire-barrier material. Provide factory-drilled mounting holes.
4. Fire Rated Cabinets: UL listed with UL listing mark with fire resistance rating of wall where it is installed, with minimum 1-hour fire rated if walls are not otherwise identified.
5. Cabinet Type: Suitable for mounting conditions shown, of the following types:
6. Recessed: Cabinet box (tub) fully recessed in walls of sufficient depth to suit style of trim shown.
7. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Fabricate trim in one piece with corners mitered, welded, and ground smooth.
8. Door Material and Construction: Manufacturer's standard steel door construction, coordinated with cabinet types and trim styles selected.
9. Door Style: Manufacturer's standard solid steel panel design with frame.
10. Door Hardware: Provide manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style shown. Provide concealed or continuous type hinge permitting door to open 180 deg.
11. Interior Finishing: Standard baked-enamel paint
12. Accessories:
    a. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
       1) Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
       2) Location: Applied to cabinet door.
       3) Application Process: Type ‘A’ Die Cut Lettering.
       4) Lettering Color: Black (Proposed alternative options are to be selected by the Architect from manufacturer’s standard selections)
       5) Orientation: Vertical.

2.4 MOUNTING BRACKETS

A. Manufacturers:

1. Larsen's Manufacturing Company.
2. Amerex Corporation.
3. JL Industries, Inc.
4. Potter Roemer; Div. of Smith Industries, Inc.

B. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

1. Color: Black.

C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

2. Orientation: Vertical.

2.5 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.

a. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish fire-protection cabinets after assembly.

2.7 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.

B. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

D. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Adjust fire-protection cabinet doors to operate easily without binding.

B. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

C. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104400

SECTION 105623 --WIRE STORAGE SHELVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following shelving :

1. Wire-Type, Four-Post Metal Storage Shelving.

B. Related Sections:

1. Division 12 “Laboratory Casework.”

1.3 SUBMITTALS

A. Product Data: Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. Shop Drawings: Show fabrication and installation details for metal storage shelving, including upright-to-shelf/arm connections, lateral bracing, and attachments to other work. Include plans, elevations, sections, details, and relationship to other work.

C. Samples for Verification: For the shelving components, manufacturer’s standard sizes..

D. Qualification Data: For Installer.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of metal storage shelving.

F. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: Manufacturer experienced in successfully producing metal shelving units similar to that indicated for this Project with sufficient production capacity to produce required units without causing delay in the Work.

C. Source Limitations: Obtain metal storage shelving through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver metal storage shelving palleted, wrapped, or crated to provide protection during transit and Project-site storage.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weatherproof, wet work in spaces is completed and dry, and ambient temperature is being maintained at the levels indicated for Project when occupied for its intended use.

1.7 COORDINATION

A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to partition and wall assemblies.

B. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving mounted on mobile storage unit carriage platforms.

C. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, and sprinklers.

PART 2 - PRODUCTS

2.1 WIRE-TYPE METAL STORAGE SHELVING

A. Wire-Type, Four-Post Metal Storage Shelving: Factory-formed, field-assembled, freestanding system without back or end panels, designed for shelves to span between and be supported by corner posts, with shelves adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

B. Available Manufacturers providing products in compliance with requirements include the following or equal:

1. Global Industrial Commercial Wire Shelving
2. (Basis of Design) Metro, Emerson Storage Solutions
3. Omega Products Corporation.

C. Basis of Design Product: MetroMax Shelving System or approved equal.

1. (Basis of Design) Metro Shelves Type 304 Stainless Steel Shelving. Dimensions: 18”W x 36”L, 24”W x 48”L

2. Framed-Type Wire Shelves: Stainless-steel wire-over-wire construction with shelf frame fabricated from same material and with same finish as posts; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.

2.2 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing

and assembly. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

2.3 MATERIALS

A. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

2.4 FASTENERS

A. Postinstalled Expansion Anchors in Concrete: With capability to sustain, without failure, a load equal to 4 times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition (mild).

B. Bolts and Nuts: Regular hexagon head type, ASTM A307, Grade A, with hex nuts, ASTM A 563, and, where indicated, flat washers.

C. Plain Washers: Round, carbon steel, FS FF-W-92.

D. Lock Washers: Helical spring type carbon steel, FS FF-W-84.

2.5 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish all steel surfaces, components, and accessories except prefinished stainless-steel and chrome-plated surfaces.

2.6 STEEL FINISHES

A. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 0.025 mm for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 0.05 mm.

1. Color and Gloss: As selected by Design Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, and true, and within erection tolerances according to manufacturer's written directions..

B. Erection Tolerances: Erect metal storage shelving with a maximum tolerance from vertical of 1/2 inch from 0 to 10 feet of height and remaining constant at a maximum of 1 inch for all heights taller than 10 feet.

3.3 ADJUSTING AND CLEANING

A. Verify that shelves and shelf-to-post connectors adjust easily and properly.

B. On completion of installation, clean exposed surfaces as recommended by manufacturer.

C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.

D. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 113100 – APPLIANCES

PART 1 - GENERAL

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of appliance.

C. Field quality-control reports.

D. Sample Warranties: For manufacturers' special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each appliance to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintains, within 250 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

1.7 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace appliances or components that fail in materials or workmanship within specified warranty period.

1. Refrigerator/Freezer and Icemaker Sealed System: Full warranty, including parts and labor, for on-site service on the product.
   a. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 APPLIANCES

A. Source Limitations: Obtain each type of appliance from single manufacturer.

B. Manufacturers and Products: Refer to schedules.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Accessibility: Where appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the ADA standards of the Federal agency having jurisdiction.

2.3 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of appliances.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install appliances according to manufacturer's written instructions.

B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.

C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain appliances.

END OF SECTION 113100

SECTION 115213 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electrically operated, ceiling recessed, front projection screens and controls.

B. Related Sections:

1. Division 05 Section "Metal Fabrications" for metal support framing for projection screens.
2. Division 10 "Visual Display Units" for additional Visual Display units.
3. Division 26 Sections for electrical service and connections including metal device boxes for switches and conduit, where required, for low-voltage control wiring.

1.3 DEFINITIONS

A. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.

B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:

1. For electrically operated projection screens and controls:

a. Location of screen centerline relative to ends of screen case.
b. Location of wiring connections for electrically operated units.
c. Location of seams in viewing surfaces.
d. Drop lengths.
e. Anchorage details, including connection to supporting structure for suspended units.
f. Details of juncture of exposed surfaces with adjacent finishes.
g. Accessories.

h. Wiring diagrams.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For projection screens to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 COORDINATION

A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Projection Screens: Obtain each type of projection screen from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.

B. Manufacturers providing products in compliance with requirements include:

1. (Basis of Design) Draper, Inc., 411 South Pearl Street, Spiceland, IN 47385; 765-987-7999.
2. Da-Lite Screen Company, Inc., 3100 North Detroit Street PO Box 137, Warsaw, IN 46581-0137, 574-267-8101
3. Stewart Filmscreen Corporation, 1161 West Sepulveda Blvd., Torrance, California 90502, 310-784-5300

2.2 VDS03: FRONT PROJECTION SCREENS

A. Electrically-operated projection screen for ceiling installation consisting of case, screen, motor, controls, electric brake, limit switches, mounting accessories, and other components necessary for complete installation
   1. (Basis of Design) Draper; Ultimate Access XL/Series E.

B. Product Characteristics:

   1. Projection screen viewing area shall be in HDTV/16:9 format. Refer to drawings for dimensions and locations.
   2. Screen fabric shall be vinyl flame retardant, mildew resistant, GREENGUARD Children & Schools certified fiberglass base laminated with PVC and coated Matte White XT1000E projection surface with opaque black backing.
   3. Gain: 1.1.
   4. Viewing angle: Uniform diffuser; no half-gain angle.
   5. Silent motor.
   6. Provide low voltage control interface and one low voltage, wall mounted, three-position control switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify rough-in openings are properly prepared.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Coordinate provision of screens with locations of other wall and ceiling mounted components such as visual display boards, casework, structural framing, light fixtures, air diffusers, ducts, and fire sprinklers to eliminate potential conflicts.

B. Coordinate requirements for blocking, construction of recesses, and auxiliary structural supports to ensure adequate means for installation of screens.

C. Coordinate requirements for power supply, conduit, and wiring required for electric screen motors and controls.

D. Coordinate screen size, mounted depth, and required edge tolerances of recessed screens with construction of with construction of suspended acoustical panel and gypsum board ceilings prior to ordering screens.

E. Coordinate interface and installation of screen and controls with Architect.

F. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions and approved shop drawings.

B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.

C. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.

1. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

D. Unless otherwise indicated on the Drawings, casings of projection screens recessed in the ceiling shall match the finished ceiling color. Coordinate color with Architect.

3.4 TESTING AND DEMONSTRATION

A. Test motorized projection screens to verify that screen, controls, limit switches, closure, and other operating components are functional. Ensure that screen is level and viewing surface plumb when extended. Correct deficiencies.

B. Demonstrate operation of screen to Owner's designated representatives.

END OF SECTION 115213

SECTION 115300 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections:
   ~~1. Division 01 Section "Allowances" for equipment allowances as noted.~~
   ~~2.~~1. Division 09 Section "Gypsum Board Assemblies" for reinforcements in metal-framed partitions for anchoring equipment.
   ~~3.~~2. Division 11 Section “Laboratory Sterilizers” for related requirements.
   ~~4.~~3. Division 12 “Laboratory Casework.”
   ~~5.~~4. Division 22 Plumbing Sections - Furnishing and installation of plumbing utilities and final connections to equipment.
   ~~6.~~5. Division 23 HVAC Sections - Furnishing and installation of mechanical utilities and final connections to equipment.
   ~~7.~~6. Division 26 Electrical and Communications Sections - Furnishing and installation of electrical utilities and final connections to equipment.

1.2 ACTION SUBMITTALS

A. Product Data for new equipment:

   1. Manufacturer's model number.
   2. Accessories and components that will be included for Project.
   3. Clearance requirements for access and maintenance.
   4. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.

B. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

C. Coordination Drawings:

   1. Indicate locations of laboratory equipment and connections to utilities.
   2. Key equipment using same designations as indicated on Drawings.
   3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.

D. Installation Drawings:

   1. Installation Drawings are a required informational submittal.
   2. Following Shop Drawing approval, installation drawings shall be provided by the Owner to the Contractor showing all installation requirements. Manufacturer shall coordinate the preparation of Shop Drawings and installation drawings with the Contractor in a timely manner.
   3. Contractor shall provide manufacturer’s installation drawings to Plumbing, HVAC and Electrical contractor(s) for the purpose of including this information in the Coordination

Drawings specified under Divisions 22, 23, and 26, and coordinate as required to ensure that this information is communicated in an accurate and timely manner.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data:

1. Provide complete data for incorporation into operations and maintenance manuals.
2. Manuals: A full set of printed and bound manuals explaining operation and operator controls shall be provided for each type of laboratory equipment.

   a. Parts List: For each unit, a complete list of component parts including original part numbers, and component cut sheets shall be included.

B. Operation and Maintenance Data: For Laboratory equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Procedures" and Division 01 Section "Operation and Maintenance Data," include the following:

1. Product Schedule: For each Laboratory equipment item, include the following:

   a. Designation indicated on Drawings.
   b. Manufacturer's name and model number.
   c. List of factory-authorized service agencies including addresses and telephone numbers.

C. Warranty: Samples of special warranty.

1.4 QUALITY ASSURANCE

A. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.

B. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with laboratory equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be complete in every respect ready for operation prior to shipment.

B. Package or crate, and brace products to prevent damage or distortion of equipment in shipping and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings or equivalent protection. Provide temporary skids under large or heavy units.

C. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory equipment until wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Locate concealed framing, blocking, and reinforcements that support laboratory equipment by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate laboratory equipment layout and installation with other work, including:

1. Layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.
2. Locations and requirements of utility service connections.
3. Laboratory casework.

1.9 WARRANTIES

A. Laboratory equipment manufacturer shall provide a written warranty to the Owner. Warranties shall be sole source type, issued directly by the equipment manufacturer. Warranty shall become effective on the date of Substantial Completion as certified by the Design Professional.

B. Warranty will specifically guarantee in written form that the equipment will, under normal operation:

1. Maintain within the specified tolerances the operational parameters specified.
2. Be free from defects due to faulty materials or workmanship under normal use and service.

PART 2 - PRODUCTS

2.1 GLASSWARE WASHER/DRYER

A. Basis of Specification: Miele PG 8583 “Laboratory Glassware Washer” with DI water connection, liquid dispensing, EcoDry Function and oil seals.

1. Products of the following manufacturers, provided they are equivalent to the basis of specification, will be considered acceptable.

   a. Getinge Group
   b. Miele

2. Utility requirements of alternate products shall be equivalent to or less than those of the basis of specification.

3. Provide allowance for accessories to be chosen by owner

B. Description:

1. Overall unit dimensions with lid: 32-1/4 – 35 14 H x 23 5/8 W x 23 5/8 D.

C. Engineering Data:

1. Plumbing:
   a. Cold water min 14.5 psi and 145 psi.
   b. Hot water: maximum of 150 F.
   c. Demineralized Water Connection line required.
   d. Drain hose.

2. Electrical: 3 phase, 208V, 3 wire.

D. Construction:

1. Free standing with single door and side panels.
2. Stainless steel type 304.

2.2 EXTRACTION ARM - EXHAUST SNORKEL

A. Three or four segmented ceiling mounted with cone capture canopy.

1. Products of the following manufacturers, provided they comply with features listed below will be considered acceptable:
   a. Alsident
   b. (Basis of Design) Movex
   c. Nederman

B. Product: Movex ME 75 Exhaust Arm. Manufacturer shall supply all accessories required to install as specified below and as indicated on the Drawings.

C. Features:

1. Low pressure drop.
2. Ceiling mounted extraction arm, 3-inch diameter, aluminum, with white polycarbonate elbows. Furnish with all appropriate brackets and connectors. Attach to structure above or overhead service carrier via powder coated metal ceiling column. Connect to the building exhaust system by metal ductwork as specified in Division 23.
3. Model Number: MET 1300-75, total length 51 inches.
4. Maximum air volume: 100 cfm
5. Arms: minimum 180° turning radius.
6. Construct arms of one short segment for connection to air-handling ceiling column, two intermediate segments, and one short segment for connection to hood attachment, with friction hinges between each segment.
7. When arm is positioned it shall not drift horizontally or vertically.
8. Do not furnish with control damper.
9. Additional accessories:
   a. Terminate with clear dome hood MEK 350-75.
10. Contractor shall design and install above ceiling support structures where and as required for attachment of ceiling column.

2.3 ICEMAKER

A. Basis of Specification: Hoshizaki America, Inc.

1. Model Number: F-450MAH, with B-300 storage bin and adjustable legs

2. Acceptable manufacturers include:
   a. Cornelius
   b. Crystal Tips Ice Systems
   c. Scottsman

B. Features:

1. Modular flake ice maker with R-404a refrigerant and non CFC and HCFC foam insulation. Ozone-depleting refrigerant is not acceptable.

2. Ice production capacity:

   a. 355 lbs per 24 hours at 70F air, 50F water temperature.

3. Bin capacity: 300 lbs (ARI-rated bin capacity: 260 lbs.)
4. Air cooled compressor– Power: 115V/60Hz/1PH, 20A
5. Stainless steel panel kit and stainless steel legs.

2.4 CYLINDER STORAGE RACKS

A. Description: Gas cylinder rack for indoor or outdoor bulk cylinder storage of gas cylinders up to 10 inches in diameter. Barricade cylinder racks surround cylinders with two inch square steel tubes, continuously seam welded and sealed with exterior grade powder paint. Cylinder rack includes two levels of welded steel chains and snaps for each cylinder.

B. Manufacturers:

1. Mott; Cylinder Storage Racks
2. First Safety;
3. USA Safety Solutions

C. First Safety: GSID-4x2
1. Cylinder rack dimensions (WxDxH): 58 W " x 26" D x 30" H.
2. Cylinder capacity: 1-8
3. Cylinder diameters supported: Up to 12”

2.5 CYLINDER RESTRAINTS

A. Description: Wall mounted cylinder restraint with cylinder strap and chain.

B. Basis of Specification: First Safety Corp. G-100 Single Cylinder Wall Bracket with supplemental G-105 chain support.

C. Acceptable Manufacturers:

1. Lab Safety Supply Co., Deluxe Wall Brackets
2. Matheson Tri-Gas, Model 510-WALL

D. Product Characteristics:

1. All steel construction.

2. Wall-mounted brackets.
3. Cylinder size: 4 – 12 inches diameter.

2.6 FLOOR MOUNTED CYLINDER RESTRAINTS

A. Description: Floor mounted cylinder restraint with cylinder strap and chain.

B. Basis of Specification: First Safety Corp. Model No. 35300 Gas Cylinder Stand with support straps.

C. Acceptable Manufacturers:

1. Lab Safety Supply Co.
2. Matheson Tri-Gas,

D. Product Characteristics:

1. All steel construction.
2. Floor Mounted
3. Back to back storage upto 6 Gas Cylinder Stand
4. Cylinder size: 4 – 12 inches diameter.

2.7 MISCELLANEOUS MATERIALS

A. Elastomeric Joint Sealants: refer to Division 07 "Joint Sealants" for requirements.

2.8 FINISHES

A. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Powder-Coat Finishes: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect and verify that all necessary utilities have been roughed in prior to equipment installation.

3.2 INSTALLATION

A. Install laboratory equipment level and plumb, according to manufacturer's written instructions.

1. Connect equipment to utilities.
2. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

B. Complete equipment assembly where field assembly is required.

1. Provide closed butt and contact joints that do not require a filler.
2. Grind field welds on stainless-steel equipment until smooth and polish to match adjacent finish.

C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions.

D. Install cabinets and similar equipment on bases in a bed of sealant.

E. Install closure-trim strips and similar items requiring fasteners in a bed of sealant.

F. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

3.3 CLEANING AND PROTECTING

A. After completing installation of equipment, repair damaged finishes.

B. Clean and adjust equipment as required to produce ready-for-use condition.

C. Protect equipment from damage during remainder of the construction period.

END OF SECTION 115300

SECTION 115313 -- LABORATORY FUME HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. General Purpose Benchtop Chemical Fume Hoods

2. Piping and wiring within fume hoods for service fittings, light fixtures, fan switches, and other electrical devices included with fume hoods.

3. Fume hood base cabinets.

4. Fume hood base stands.

5. Work tops within fume hoods.

6. Fume Hood Accessories.

B. Fume Hood Accessories and coordination with other trades:

1. Work of this Section shall include furnishing and delivering all fume hood service fixtures, accessory fittings, electrical receptacles and switches as listed in the specifications, equipment and fixture schedules and as shown on the Drawings. Plumbing fittings mounted on the fume hood superstructures shall be preplumbed as specified herein and conform to the requirements of Division 22. Electrical fixtures shall be prewired as specified herein and conform to the requirements of Division 26. Fume hood superstructures shall be listed to Underwriters Laboratories (UL) Standards for Safety. Final plumbing and electrical connections shall be made under Divisions 22 and 26.

C. Related Requirements:

1. Division 01 Section "General Commissioning Requirements" for commissioning of Fume Hoods.

2. Division 09 Section "Gypsum Board Assemblies" for reinforcements in metal-framed partitions for anchoring fume hoods.

3. Division 12 “Metal Laboratory Casework.”

4. Division 12 “Laboratory Sinks and Fixtures”.

5. Division 22 Plumbing Sections - Furnishing and installation of plumbing utilities and final connections to fume hoods

6. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for field quality-control testing of fume hoods.

7. Division 23 Section "Instrumentation and Control for HVAC" for VAV controls for fume hood exhaust.

8. Division 26 Electrical and Communications Sections - Furnishing and installation of electrical utilities and final connections to fume hoods.

D. Fume Hood Accessories and coordination with other trades:

1. Work of this Section shall include furnishing and delivering all fume hood service fixtures, accessory fittings, electrical receptacles and switches as listed in the specifications, equipment and fixture schedules and as shown on the Drawings. Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed as specified herein and conform to the requirements of Division 22. Electrical fixtures shall be prewired as specified herein and conform to the requirements of Division 26. Fume hood superstructures shall be listed to Underwriters Laboratories (UL) Standards for Safety. Final plumbing and electrical connections shall be made under Divisions 22 and 26.

1.3 REFERENCES AND STANDARDS

A. ASHRAE 110, latest edition, Method of Testing Performance of Fume Hoods.

B. Work shall conform to the recommended practices of the Scientific Equipment and Furniture Association (SEFA), except as superseded by this specification:

1. SEFA 1: Fume Hoods.
2. SEFA 2: Installation.
3. SEFA 3: Laboratory Work Surfaces.
4. SEFA 7: Fixtures.
5. SEFA 8 M: Laboratory Grade Metal Casework.

C. Occupational Safety and Health Administration, Federal Register 29 CFR Part 1910, "Occupational Exposures to Hazardous Chemicals in Laboratories."

D. State OSHA regulations, if developed for state of the project location.

E. American National Standards Institute/American Industrial Hygiene Association (ANSI/AIHA) Z9.5 "Standard for Laboratory Ventilation."

F. National Fire Protection Association (NFPA) 45 "Standard on Fire Protection for Laboratories Using Chemicals."

G. American Conference of Government Industrial Hygienists (ACGIH) "Industrial Ventilation."

1.4 FUME HOOD GENERAL DESIGN REQUIREMENTS

A. General: Fume hoods shall function as ventilated, enclosed workspaces, designed to capture, confine and exhaust fumes, vapors and particulate matter produced or generated within the enclosure.

B. Air Flow: Fume hood design shall minimize eddying of air currents at the hood face, and shall minimize turbulence and vortexes in all portions of the hood interior.

C. Face Velocity: Fume hoods shall provide consistent and safe air flow through the hood face. Variations of face velocity shall not exceed 10% of the average face velocity at any designated measuring point as defined in this specification.

D. Static Pressure Loss: Fume hood shall minimize static pressure loss with adequate slot area and appropriately designed exhaust collar configuration. Maximum average static pressure loss readings, taken three diameters above the hood outlet from four points, 90 degrees apart, shall not exceed the maximum values defined in this specification.

E. Exhaust Volume: Fume hoods shall maintain an exhaust volume as specified by manufacturer.

F. Average illumination of work area: Minimum 80 foot-candles. Work area shall be defined as the area inside the superstructure from side to side and from face of baffle to the inside face of the sash, and from the working surface to a height of 28 inches.

G. Noise Criteria: Fume hoods shall demonstrate 50 NC performance value when connected to a 50 NC HVAC source. Readings shall be taken 3 feet in front of open sash at 80 fpm face velocity, with demonstration test data using octave band analysis.

1.5 EXHAUST VOLUME AND STATIC PRESSURE REQUIREMENTS

A. Requirements specified are those published by the basis of design manufacturer. Published values for products by alternate manufacturers shall not exceed exhaust CFM values by more than 10%.

B. Exhaust CFM and static pressure: As scheduled on Drawings.

1.6 SUBMITTALS

A. Product Data: Submit complete product data for each type of fume hood and accessory specified, illustrating compliance with specified requirements. Include data demonstrating compliance with UL and ASHRAE standards listed under the “Quality Assurance” article of this specification.

B. Shop Drawings: For laboratory fume hoods.

1. Include plans, elevations, sections, and attachment details.

2. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

3. Indicate locations and types of service fittings together with associated service supply connection required.

4. Indicate duct connections, electrical connections, and locations of access panels.

5. Include roughing-in information for mechanical, plumbing, and electrical connections.

6. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from the above items.

7. Include layout of fume hoods in relation to lighting fixtures and air-conditioning registers and grilles.

8. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples: Samples: Submit 6 x 6 inch samples of each type of finish for fume hood enclosure, lining, work surfaces and for other pre-finished equipment and accessories for approval by Architect.

D. Delegated-Design Submittal: For fume hoods indicated to comply with seismic performance requirements and design criteria.

E. Product Test Reports: Showing compliance with specified performance requirements for as-manufactured containment and static pressure loss, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Warranty.

I. Installation Drawings:

1. Installation Drawings are a required informational submittal.

2. Following Shop Drawing approval, installation drawings shall be provided by the manufacturer to the Contractor showing all installation requirements. Manufacturer shall coordinate the preparation of Shop Drawings and Installation Drawings with the Contractor so that this information can be provided to affected trades in a timely manner.

3. Contractor shall provide manufacturer's installation drawings to Plumbing and Electrical contractor(s) for the purpose of including this information in the Coordination Drawings specified under Divisions 22 and 26, and coordinate as required to ensure that this information is communicated in an accurate and timely manner.

J. Instructions:

1. Instructions are a required informational submittal.

2. Instructions to be inscribed on instruction plate to be attached to hood, as specified in Part 2 of this Section.

3. Written instructions in booklet form providing additional details on safe and proper operation and maintenance, including testing and calibration of safety monitor/alarm system.

4. Instructions describing procedures for Owner's re-certification of hoods, following initial certification by the installing contractor.

K. Maintenance Data:

1. Provide complete data for incorporation into operations and maintenance manuals.

2. Manuals: A full set of printed and bound manuals explaining operation and operator controls shall be provided for each type of fume hood.
   a. Parts List: For each unit, a complete list of component parts including original part numbers, and component cut sheets shall be included.

3. Provide manufacturer's recommended maintenance schedule, procedures and operation and maintenance instructions.

4. Provide a listing of maintenance materials and/or special tools required for regular maintenance.

5. Provide a listing including address and telephone number of all manufacturer employed and/or independent authorized service agencies approved by the manufacturer providing service to the project location.

L. Furnish complete touchup kit for each type and color of fume hood finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged fume hood finish.

1.7 QUALITY ASSURANCE

A. Single source manufacturing: Provide all fume hoods specified herein as complete units produced by one manufacturer for single source responsibility. Acceptable manufacturers are listed below.

1. Single source procurement: All fume hoods and accessories specified in this Section shall be furnished through a single laboratory furniture manufacturer. Acceptable manufacturers are listed in Division 12.

2. Manufacturer's Qualifications:
   a. Manufacturer shall be an established organization with production facilities specializing in the type of fume hoods specified herein, with proper tools, dies, fixtures and skilled workmen. The manufacturer shall have demonstrated the ability to produce the specified fume hoods of the highest quality and a proven capacity to complete an installation of this size and type within the required time limits. The manufacturer shall also have engineering, production, and testing departments experienced in the design, fabrication, installation, and testing of fume hoods specified herein. As a minimum, manufacturer shall evidence the following:
   b. Five or more years of successful company operation as a manufacturer of laboratory fume hoods meeting the quality and performance requirements of this project, with ten or more installations of equal or larger size and complexity completed during that time period.

B. For each type and size of VAV Fume Hood specified, test data indicating a leak rate of less than 0.05 ppm when challenged at 4.0 ppm in accordance with ASHRAE Standard 110-1995 at a face velocity of 100 fpm regardless of sash position.

C. Data indicating each type and style of fume hood has been tested by a Nationally Recognized Testing Laboratory (NRTL) and certified by them to meet the applicable UL standards.

1. Each type and size of Fume Hood specified shall satisfy UL 1805 requirements, with all fume hoods bearing the UL label accordingly.

2. Each fume hood with factory installed electrical wiring and devices (“prewired”) shall satisfy UL 61010A-1 requirements, with all fume hoods bearing the UL label accordingly.

D. The bidder shall review the project drawings and specifications, and identify and be responsible for any alterations to the mechanical or electrical services as scheduled herein and as shown on the drawings which are necessary to accommodate the manufacturer's product requirements. The bidder shall include in his bid sufficient monies to cover such alterations at no cost to the Owner.

E. Preinstallation Meetings:

1. After bid acceptance and award, a preconstruction meeting will be held between the fume hood manufacturer, Architect and Construction Manager.

2. The meeting will include manufacturer’s project manager and/or sales representative, and manufacturer’s field installer.

3. Purpose of the meeting will be to review submittal requirements, physical and building service requirements, rigging requirements for installation in the facility, installation of laboratory airflow controls equipment and other work to be provided by others, where applicable, and other issues related to fume hood design, manufacture and installation.

F. Service: Replacement parts for all fume hoods and accessories shall be available direct to the owner from the manufacturer or from local independent authorized service agencies approved by the manufacturer.

1.8 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for lateral support of fume hoods.

B. Coordinate installation of fume hoods with laboratory casework and other laboratory equipment.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be complete in every respect ready for operation prior to shipment.

B. Package or crate, and brace products to prevent damage or distortion of equipment in shipping and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings or equivalent protection. Provide temporary skids under large or heavy units.

C. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install fume hoods until wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Locate concealed framing, blocking, and reinforcements that support fume hoods by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.11 CONTINUITY AND COOPERATION WITH OTHER TRADES

A. It shall be the responsibility of the Contractor to coordinate with other trades.

B. Fume hoods, as installed, are considered to be finished equipment and shall be protected from damage accordingly.

C. Painting and Other Finishing Trades. At no time shall the fume hood be used by tradesmen as a workbench, scaffolding, etc. It is the responsibility of the Contractor to perform minor wall touch-up around laboratory equipment and to caulk between laboratory equipment and wall(s) as indicated on drawings. The Contractor shall protect installed laboratory equipment from debris, paint and damage.

1.12 WARRANTIES

A. For each item, the fume hood manufacturer shall provide a written warranty to the Owner. Warranties shall be sole source type, issued directly by the fume hood manufacturer. Warranty shall become effective on the date of Substantial Completion as certified by the Architect.

B. Warranty will specifically guarantee in written form that the equipment will, under normal operation:

1. Maintain within the specified tolerances the operational parameters specified.

2. Be free from defects due to faulty materials or workmanship under normal use and service.

C. Term: 1-year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Provide products from one of the following manufacturers or equal:

1. (Basis of Design) Kewaunee Scientific Corporation
2. Mott Manufacturing
3. CiF Lab Solutions.

B. Basis of Design: Fume Hood drawings and specifications have been based on products for which specific manufacturer and model numbers are indicated below as the Basis of Specification. These model numbers are provided for the identification of sizes, capabilities, utility requirements,

accessories, options and general characteristics of the individual products. Identification of specific models is not intended to preclude the use of equivalent products by any acceptable manufacturer listed above which fully comply with these specifications and is otherwise equal to the Basis of Specification.

2.2 CHEMICAL FUME HOODS

A. Basis of Design: Kewaunee Scientific "**Supreme Air LV Venturi".** High performance, high efficiency ergonomically designed general purpose fume hood.

B. Product Characteristics:

1. Variable Volume Operation

2. Sash: Combination- vertical, horizontal at ADA hoods and as indicated in drawings; automatic.

3. Width: Refer to drawings.

4. Depth: Nominal 30 inches except where indicated otherwise on Drawings.

5. Sash Operating and Setup Heights: Sash Operating Height – 18", Sash Setup Height – 28".

6. Face velocity: 100fpm regardless of sash position.

C. Fume Hood Services and Accessories:

1. Work Surface: Epoxy Resin.

2. Vacuum, Natural Gas or as indicated in drawings.

3. Cup Sinks: One cup sink at fume hoods smaller than 6 feet. Two cup sinks at hoods 6 feet and larger.

4. Service Fixtures: As indicated on Drawings.

5. Electrical Outlets: One 120V,20A duplex outlet per side.

6. Ceiling Closure Panel: Provide steel superstructure enclosure panels at all exposed sides of fume hoods. Front enclosure shall incorporate a service access panel.

2.3 FUME HOODS – GENERAL

A. The following general requirements shall apply to all laboratory fume hoods

2.4 FUME HOOD MATERIALS

A. Steel:

1. Construction: High quality, cold rolled, galvanized mild steel meeting requirements of ASTM A1008; gauges U.S. Standard.

2. Exterior Finish: As specified for Steel Laboratory Casework.
   a. Color to match selection for Steel Laboratory Casework, utilizing same powder coat formulation.

B. Stainless steel: Type 304 and 316; gauges U.S. Standard.

C. Safety glass: 7/32" thick minimum clear laminated safety glass.

D. Gaskets: 70 durometer PVC for interior access panels. Provide gasketed interior access panels to eliminate air leakage and to retain liquids inside hood.

E. Fastenings:

1. Exterior structural member attachments: Sheet metal screws, stainless or zinc plated steel.

2. Interior fastening devices: Concealed type. Exposed screws are not acceptable

3. Exterior panel member fastening devices: Corrosion resistant, non-metallic material. Exposed screws are not acceptable.

F. Instruction and Name Plates: Corrosion resistant steel or plastic plate.

G. Installation Adhesives and Glues: Use installation adhesives within the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24)

2.5 FUME HOOD CONSTRUCTION

A. Exhaust outlet: Rectangular or round, with ends radiused, shaped and flanged.

1. Construction:
   a. General purpose fume hoods: Polyethylene or min. 18 GA Type 304 or 316 stainless steel.
   b. Special purpose fume hoods: 18 GA min., Type 316 stainless steel.

B. Duct transition collar: Provide exhaust duct transition from the hood exhaust outlet to the building exhaust system round duct connection. The required, draw band type duct connection detail is indicated on the Mechanical Detail Drawings. Duct connection diameter is indicated on the Mechanical HVAC Plan Drawings. Fabricate transition from the same material as the exhaust outlet.

C. Superstructure: Rigid, self-supporting assembly of double wall construction, maximum 4 7/8" thick.

1. Superstructure wall shall consist of an outer shell and a corrosion resistant inner liner. Wall shall house and conceal steel framing members, attachment brackets, and remote operating service fixture mechanisms, piping and services. Outer shell shall be constructed as follows:
   a. Exterior sidewalls and upper front panel: Powder coated sheet steel.
   b. Lower front panels: Powder coated sheet steel.

2. Panel frame construction shall be a “full frame” type design, consisting of minimum 16 gauge galvanized steel members.

3. Panels and brackets shall be attached so as to eliminate exposed screw heads and metallic brackets from hood interior. Interior and exterior panels shall be removable without disassembly of the frame structure.

D. Ceiling closure panels: Minimum 18 gauge cold rolled steel; finish to match hood exterior.

E. Access opening perimeter: Airfoil or streamlined shape with all right angle corners radiused or angled.

1. Bottom foil: Low profile type, providing a spill containment trough and pass-through access space for electrical cords. Front edge shall be ergonomically radiused.
   a. Bottom horizontal foil shall provide air bypass when sash is in the fully closed position.
   b. Construction: Sides: 14 gauge minimum Type 304 stainless steel.

2. Opening shall incorporate rubber bumper stops against which sash(es) will open and close.

F. Fume Hood Sash

1. Vertical sash: Vertical rising sash. The sash shall be counterbalanced to prevent tilting and binding during operation. The sash shall provide a 32” or higher viewing height.

2. Sash design shall include:
   a. Sash operating height: 18” or as scheduled.
   b. Sash set-up height: 28” minimum, or as scheduled.
   c. The sash shall provide a 32” -38-1/2” viewing height, with a maximum opening of 28”.
   d. Counter balance system shall prevent sash tilting and permit easy “finger tip” operation from any point along the full width. A maximum of 7 pounds of force shall be required to raise or lower sash throughout its full operating height.
   e. Sash auto-return feature: The sash shall be configured so that when lifted higher than the scheduled operating height, the sash will return the operating position automatically when released.
   f. Sash Latch: Fume hood shall incorporate a mechanism for latching the sash in the full-open position for hood set-up.
   g. Sash handle: Type 304 Stainless Steel.

G. Restricted Type Airflow Bypass System: The bypass system shall adjust face velocity and exhaust volume through the raising and lowering of the sash when connected to a VAV laboratory airflow control system. Bypass shall be sufficient in size to allow 25% airflow with sash closed. Bypass must be achieved through low resistance opening or grille at the top of front lintel panel, and shall be designed to provide a smooth downward flow effect.

1. Bypass design shall be coordinated with laboratory airflow control system manufacturer.

2. Provide for fume hoods scheduled to be connected to a variable volume (VAV) exhaust system.

H. Fume hood liner:

1. General Purpose Fume Hoods: Reinforced Phenolic Resin Lining: Interior liner panels shall be 1/4" thick made from a compression molded cellulose fiber reinforced phenolic resin core with integrally cured white melamine surfaces. Interior liner panels shall be fastened using stainless steel screws with plastic covered heads.

2. Adjustable Baffles: Baffle adjustment shall be accomplished via remote, toggle style, one handed, single point control. Adjustment shall be possible while hood is in use, without disturbing apparatus, with sash in either the open or closed position. Manipulation of baffle mechanism shall not require the use of tools.
   a. Control Handle: Toggle style control handle with acid-resistant label indicating proper control handle location for baffle function.
   b. Remote Adjustment Mechanism: Design shall rigidly correlate control handles to baffle positioned. Cable type adjustments are not acceptable.
   c. OSHA Compliance: Baffle design must comply with OSHA guidelines requiring it be easily reached and adjusted with only one arm in hood. Designs requiring internal manipulations greater than 6” into hood are not acceptable.
   d. All baffle supports/brackets inside of hood are to be non-metallic.

I. Electrical services: The fume hood superstructure shall be pre-wired in the factory, and bear a UL 61010A label certifying acceptable wire gauge, connections, fixtures and wire color-coding, etc. Electrical fixtures shall consist of the following:

1. Duplex receptacles:
   a. Type: Hospital grade, 20 Amp., 125 volt AC, and 3-wire polarized grounded with ground fault interruption. The receptacles shall be side wired only to insure a positive connection.
   b. Quantity: One per side. Provide additional 250 V.A.C. and / or 125 V.A.C. devices where scheduled or indicated on the Drawings.
   c. Color and Finish:
      1) Receptacles: Black.
      2) Flush plates: Stainless Steel.

2. Fume Hood Light Fixtures: High-efficiency, LED light fixtures installed in fume hood roof. Provide ¼” thick safety glass panel cemented and sealed to the hood roof. Access for lamp and ballast replacement shall be through upper front closure panel of fume hood.
   a. Interior of fixture: Specular or white, high reflecting plastic enamel.
   b. Size of fixture: Largest possible, up to 48" for hoods with superstructures up to six feet. Provide two 36" fixtures for hoods with eight foot superstructures.
   c. Include lamps with fixtures.
   d. Illumination: Per performance values, Part 1 of this Section.
   e. Light switch: Device shall be a timer equal to Watt Stopper, Inc. model TS-400 digital time switch; black color. Wiring and rating of the light switch shall be based upon ballast load requirement.

3. Where required, provide concealed, pre-wired duplex receptacle(s) for fume hood Safety Monitor/Alarm System. Manufacturer shall coordinate specific requirements with alarm system vendor and/or Division 23 contractor and configure fume hoods accordingly.

4. Receptacles, lighting, electrical fittings and wiring are to be installed in accordance with applicable codes and Division 26 specifications. Wiring shall terminate in a single specification grade service junction box located on the fume hood roof. Final connection shall be by Division 26.

J. Plumbing Services: Provide piping for all service fixtures from point of service connection to valve and from valve to outlet, and as otherwise required to provide completely factory prepiped fume hoods. Point(s) of service connection shall be two inches above the hood roof.

1. Single Source Responsibility: All fume hood remote control valves, fittings and accessories shall be furnished by a single fixture manufacturer.

2. Control Valves:
   a. Each fume hood service fixture shall be controlled by a remote valve; extension rods are not acceptable.
   b. Valve Construction: As specified for Laboratory Service Fittings in Division 12.
   c. Handles: Molded nylon hooded type; color to match service fixture index color with white, tan or gray index disk matching Division 12 service fixture finish.
   d. Handles at ADA Fume Hoods: Molded nylon lever type handles; color to match service fixture index color with white, tan or gray index disk matching Division 12 service fixture finish.
   e. Mounting: Control valves shall be mounted on the front panel of the fume hood and installed from behind panel, secured with an external locking ring, with all working components of the valve accessible from the exterior face of the hood superstructure. The centerline of the valve inlet and outlet shall be parallel and 1-1/8 inches apart. Valves shall have a threaded collar to hold the valve in place.
      1) An angled valve stem joint shall be provided for fume hoods with airfoil 45 degrees to the side wall of the fume hood, or where otherwise required so that valve handles are perpendicular to the airfoil surface.
      2) Mounting at ADA fume hoods shall be as required by the manufacturer's ADA compliant design, with all components of the valve requiring service access accessible from the exterior of the hood.

3. Outlet Fittings:
   a. Basis of Design: The following model numbers correspond to ColorTech by Water Saver Faucet Co.:
      1) Cold Water: Panel mounted turret with 6" rigid gooseneck; CT071-WSA.
      2) Other Services: Panel mounted flange with 45 degree angle, seven serration hose end. CT022-WSA.
      3) Additional fittings: Provide 50% of Cold Water fixtures at each fume hood, but not less than one per hood, with an aspirator type fitting, Watersaver model CTB0127S or equal.

4. Fixture Finish:
   a. Service fittings and color-coded components: Color coded, acid and solvent resistant epoxy powder coat finish applied over a fine sandblasted surface, properly cleaned.
   b. Valves and exposed, non-color coded components: Chemical resistant epoxy powder coat finish as specified for Laboratory Service Fittings in Division 12.
   c. Color: Color coding of hood service fixtures and remote control valves, and finish of non-color coded fixture components shall be as specified for Laboratory Service Fittings in Division 12.

5. Fixtures shall operate with the following maximum working pressures without leak or failure:
   a. Water: 145 PSI
   b. Non-Burning Gas: 145 PSI
   c. Burning Gases: 100 PSI
   d. Special Water Fittings: 145 PSI
   e. Oxygen Fittings: 145 PSI

6. Cup Sinks:
   a. Material and Finish: Matching work surface.
   b. Size: Nominal 3” X 6”
   c. Design: Anti-splash design with a horizontal rear outlet not extending more than 7” below the work surface. Install flush with the recessed work surface. Design and installation shall allow the installation of trap and piping behind fume hood base cabinets. Designs requiring sink cabinets below fume hoods to accommodate traps are not acceptable.
   d. Accessories:
      1) Screen: Type 316L stainless steel, 0.028 wire diameter, 8 by 8 mesh per square inch.
      2) Provide swivel sink strainer adapter, Town & Country Plastics Model PP-18; R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number 31595-158.

7. Vacuum Breakers: All water line(s) serving fume hood fittings shall be protected by atmospheric vacuum breakers. Vacuum breakers shall be installed panel mounted to the exterior of the fume hood superstructure, in an exposed, accessible location remote from light fixtures, electrical outlets or other energized devices. Vacuum breakers shall be installed as an integral part of the manufacturer’s pre-piping of the fume hood.
   a. Vacuum breakers shall be certified per ASSE Standard 1001.

8. Installation: Piping materials and installation for each type of service shall be as specified under Division 22. Pressure test and label all pre-piped plumbing lines in the factory.

K. Work Surfaces:

1. Epoxy Resin: Hood work surfaces shall be 1-1/4" thick molded epoxy resin made in the form of a watertight pan, not less than 3/8" deep to contain spillage with a 6" wide safety ledge across the front edge.
   a. Color: To be selected by architect from manufacturers full line of colors.

2. Ventilation Openings in Work Surface: Where required to ventilate Corrosive Storage Cabinets or other items, openings shall be made in the factory and furnished with a ½” high sealed lip with radiused edges to contain spillage. Lip shall be epoxy resin or similar chemical resistant material, of a color matching the work surface. Exposed plastic vent piping is not acceptable.

L. Blowers and Fans: Fume Hoods shall operate as specified by connection to the facility exhaust system at the scheduled connection exhaust volume and static pressure. No additional blowers or fans shall be required for operation.

2.6 FUME HOOD ACCESSORIES

A. Safety Monitor/Alarm System:

1. All fume hoods shall be monitored and alarmed by Division 23 as indicated in the Mechanical Drawings and specifications. Construction Manager and Fume Hood Manufacturer shall coordinate the installation of monitors, sensors, etc. and associated work with Division 23 as required.
   a. Provide a transformer as part of the factory wiring for use by the controls contractor to power the fume hood monitors.
   b. Provide factory punched necessary holes and openings for installation of the Laboratory Fume Hood Monitor under Division 23.

c. Signage mounted on the fume hood is to be provided per Division 23 in regards to the fume hood monitor

PART 3 - EXECUTION

3.1 GENERAL

A. Provide reinforcing and anchorage for built-in products.

B. Insulate between dissimilar metals, and metal and concrete or masonry to prevent electrolysis.

C. Equipment installation shall include all components, connections, devices and controls required for full safe and code-compliant operation, including all electrical and plumbing components required by jurisdictional authorities, and to protect the equipment from damage during operation; all factory-installed electrical components shall be UL approved.

D. Locations and quantities of fume hoods are indicated on the drawings.

3.2 EXAMINATION

A. Prior to beginning installation, manufacturer shall examine and verify installation areas and work of other trades for:

1. Correct installation and service dimensions.

2. Inspect and verify that all necessary utilities have been roughed in prior to equipment installation.

B. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Installation and start-up shall be performed by manufacturer's personnel or manufacturer's authorized representative. Manufacturer shall supply factory trained, on-site supervision at all times when work of this section is performed.

B. General: Install fume hoods according to manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Comply with requirements for installing water and laboratory gas service fittings and electrical devices.

1. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink and work top-mounted

fittings in sealant recommended by manufacturer of sink or work-top material. Securely anchor fittings to fume hoods unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Field testing requirements:

1. Perform tests in field to verify proper operation of the fume hoods before they are put in use, using only qualified personnel.

2. Perform tests after installation is complete, the building ventilation system has been balanced, all connections have been made, and written verification has been submitted by the Contractor that the above conditions have been met.

3. Verify that the building make-up air system is in operation, the doors and windows are in normal operating position, and that all other hoods and exhaust devices are operating at designed conditions.

4. Correct any unsafe conditions disclosed by these tests before proceeding with additional test procedures.

B. Installation shall be accomplished by the manufacturer’s authorized agent. The manufacturer's project manager shall coordinate the installation of the units, field check the equipment, and shall instruct Owner's personnel on proper operation and preventive maintenance.

C. Field test installed fume hoods according to ASHRAE 110 “As Installed” to verify compliance with acceptable results as defined by ANSI/AIHA Z 9.5.

1. Adjust fume hoods, hood exhaust fans, and building's HVAC system, or replace hoods and make other corrections until tested hoods perform as specified.

2. After making corrections, retest fume hoods that failed to perform as specified.

3. Scope: Test all fume hoods.

4. Submit complete test report for each fume hood, as described under Submittals section.

D. Provide documentation for University and Fire Marshall that the following standards have been met:

1. AW ANSI/UL 723 or ASTM E 84 flame spread ratings.
2. NFPA 45, article 8.8.1.3: Spill Containment.

E. Requirement for chemical fume hoods to have a means of preventing overflow of a spill of 2 liters (0.5 gallon) of liquid

3.5 FIELD CERTIFICATION

A. Fume Hood Manufacturer shall field test and certify each installed unit for use using approved testing and documentation procedures.

B. 30 days or more prior to commencement of certification testing, notify Owner's Environmental, Health and Safety (EH&S) Office to ensure fume hood certification procedures are in accordance with the Owner's current policies and procedures, and to provide Owner the opportunity to observe fume hood certification.

C. Project substantial completion shall be withheld until all required fume hood certification letters, tests, and reports have been submitted to and approved by the Architect.

D. Prepare and submit documentation describing proper methods for Owner's re-certification of each type of fume hood and include in O&M manuals, as described in "Submittals" article above.

3.6 FINAL ACCEPTANCE

A. Following field certification and prior to final acceptance, the Owner's EH&S Office shall perform confirmatory testing to ensure that fume hoods and monitors are operating as intended. Construction Manager shall communicate relevant project milestones to Owner's representative so that such confirmatory testing will occur without affecting the project schedule.

3.7 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 115313

SECTION 115319 -- LABORATORY STERILIZERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Medium Laboratory Sterilizers.
2. Plumbing and electrical service.
3. Accessories.

B. Related Requirements:

1. Division 01 "Operating and Maintenance Data".
2. Division 01 "Demonstration and Training".
3. Division 01 "General Commissioning Requirements".
4. Division 22 – Plumbing: Domestic water, sanitary waste and vent piping.
5. Division 23 – Heating, Ventilating, and Air Conditioning Equipment: Ducts.
6. Division 26 – Electrical: Power, wiring, and devices.

1.3 UNDIVIDED RESPONSIBILITY

A. Unless specified otherwise, because of special coordination requirements, the scope of work described in this Section shall be provided by the supplier of the Section 123553 scope of work.

1.4 REFERENCES

A. ASME Code, Section VIII, Division 1 for Unfired Pressure Vessels.

B. ASME Code, Section IX for Boiler and Pressure Vessels

C. AWS, American Welding Association

D. ASTM A240 – Specification for Stainless Steel

E. ASTM B88 – Specification for seamless, copper tubing.

F. ASTM B43 or B135 – Specification for Seamless Red Brass Tubing.

G. AAMI ST46 Steam Sterilization and Sterility Assurance.

H. UL Standard 544.

1.5 ACTION SUBMITTALS

A. Product Data: Provide detailed documentation including sterilizers proposed indicating specific materials, components, systems, and performance characteristics. Include specific comment on the anticipated life cycle of the door gaskets under constant use as described in the design requirements and regular maintenance schedule described in the performance requirements.

B. Shop Drawings:

1. Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details, finished and materials dimensions, and schedules.
2. Show relationship to adjoining materials, and construction and requisite service, operating and installation clearances (width, depth, and height).
3. Layout shall include relationship to light fixtures and ventilation registers, grilles and diffusers.
4. Identify connection points and sizes to building services and systems and locations of floors drains and/or floor sinks.
5. Provide clear identification where equipment requirements deviate from the service/utility provisions identified in the Construction Documents.
6. Verify that component parts and assembly of each item will support superimposed loads, without deflection detrimental to function, appearance and safety.
7. Provide flow rates, pressure drops, temperature and pressure requirements, voltage and amperage, etc.
8. Indicate service requirements, loads, and rough-in locations of piped services and electrical connections.

1.6 INFORMATION SUBMITTALS

A. Provide piping, wiring, and/or control diagrams, including connection points and sizes to building services and systems.

B. Proposed cycle times.

C. Statement of installer qualifications.

D. Notice of factory testing.

1. Factory Acceptance Test (FAT): Keep the following paragraph if a FAT is required.
2. Factory Authorized Testing (FAT) Procedures: Requirements and Documentation, including NIST calibration documentation.
3. Manufacturer's installation, start-up and adjustment instructions.
4. Start-up and field test reports.
5. Demonstration and instruction statement from Owner

E. Closeout submittals:

1. Operations/Maintenance Manuals:

a. Operating and maintenance manuals that describe proper operating procedures. Provide in hard copy and electronic formats.
b. Maintenance and replacement schedules.
c. Components parts list, including non-proprietary parts list with manufacturer’s original parts numbers.

d. Closest factory representative for components and service.
2. Start-up report.
3. Demonstration and instruction report.

1.7 QUALITY ASSURANCE

A. General:

1. Laboratory sterilizers specified in this section shall be the provided by a single manufacturer.
2. Work of this section requires close coordination with work of Divisions 22, 23, and 26 as well as installation of Owner furnished components and work specified in other Sections.
   a. Sequence work to assure an orderly progress in the project without removal of previously installed work and so as to prevent damage to finishes and products.
3. Refer to the Laboratory Equipment Schedule on the drawings.

B. Manufacturer's Qualifications:

1. Manufacturer shall specialize in manufacture of products specified herein with a minimum of ten years of experience.
2. Manufacturers for work in this section shall have established organizations and production facilities including tools, equipment and special machinery necessary for the fabrication and installation of the type of equipment specified, with skilled personnel, factory-trained workers and an experienced engineering department.
   a. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.
3. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.
4. Upon request, manufacturer shall provide three references of similar installations.

C. Installer Qualifications:

1. Installer for work in this section shall have an established organization including tools, equipment and special machinery necessary for specializing in the installation of the type of equipment specified, with skilled personnel and factory-trained workers.
   a. Each shall have the demonstrated knowledge, ability and the proven capability to install the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.
2. Firm specializing in installation of products specified, with a minimum of five years of experience, and authorized by the manufacturer to install product.
3. Upon request, installer shall provide three references of similar installations.
4. Installer shall have replacement parts, tools, equipment, apparatus, devices and other items required for normal and emergency maintenance, and employees fully skilled in equipment maintenance, within 2 hours arriving time of project site.

D. Preconstruction meeting: After bid acceptance and award, a preconstruction meeting will be held between the sterilizer manufacturer, University, Architect and Contractor.

1. The meeting will include manufacturers' sales representative, manufacturers design engineer and manufacturers field installer.
2. The purpose of the meeting will be to review physical requirements for autoclaves, service requirements for autoclaves, rigging requirements for installation in the facility, containment barrier detailing and other issues related to autoclave design and installation.

E. Containment Quality Assurance

1. Submit with shop drawings a copy of biological challenge test results indicating each type of Sterilizer passes in accordance with AAMI ST46 Steam Sterilization and Sterility Assurance prior to commencement of manufacturing of units for the contract.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of steam sterilizers only after wet operations in building are completed.

B. Provide receiving, distribution, and storage areas of sufficient size and capacity to accommodate crated equipment.

C. Store steam sterilizers in a ventilated place, protected from the weather, with relative humidity therein of 50 percent or less at 70 degrees F [21.1degC].

D. Protect work of this section before, during and after installation, including the installed work and materials of other trades.

E. Any damage as a result of this contractor's work will be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

F. At no time shall personnel use the steam sterilizer equipment as a workbench, scaffolding, or other uses.

G. Protect steam sterilizer equipment from debris, paint, and damage in the course of construction.

1.9 WARRANTY

A. Warrant each pressure vessel against failure under normal operating conditions for 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sterilizers shall be capable of passing biological challenge tests as described in AAMI ST46 Steam Sterilization and Sterility Assurance.

B. Sterilizers shall be capable of daily operations described in the design requirements with no regularly scheduled maintenance for a period of one year.

C. Source Quality Control

1. Sterilizers requiring Factory Acceptance Test (FAT):
   a. Medium autoclaves.
2. Sterilizer shall be provided with service identical to those that will be provided on site, including electrical service, and piped services connections, flows, and temperature, as applicable.

3. The manufacturer shall:
   a. Issue Factory Acceptance Test protocols and notification to the Owner at least 30 days in advance of scheduled testing for Owner comment and approval.
   b. Execute tests and measurements.
   c. Analyze test results.
   d. Describe deviations in test report and make corrections. Retest/repeat procedures, if required.
   e. Check that registered deviations are complete and documentation is correct.
   f. Verify calibration of test equipment.
   g. Check the conclusion of the test conformity.
   h. Sign test report after completion and submit to Owner.

4. Owner's authorized representative shall have the right to inspect work during and after fabrication completion, and shall perform and witness testing.
   a. This inspection shall occur at the vendor's manufacturing facility.
   b. Facility shall have utilities as required to perform the full testing of the sterilizer.
   c. The representative's decisions to reject material or workmanship for non-compliance with the Specification, Drawings and purchase order shall be final.

2.2 LABORATORY STERILIZERS (AUTOCLAVE): SMALL~~MEDIUM~~s

A. Description: Prevacuum steam sterilizers efficiently sterilize heat- and moisture-stable materials and are equipped with prevacuum, gravity, liquid and all applicable test cycles. The autoclave minimizes condensation with a fully jacketed chamber and lessens the chance of air entering the chamber through a non-lubricated, steam activated gasket with a 2-year warranty. ~~Process up to fifteen, 25lb trays per cycle in the 60" unit.~~

1. (Base Product) Manufacturer and Product: Steris; AMSCO 250LS~~400~~ Small~~Medium~~ Steam Sterilizer or comparable product by acceptable manufacturer.

2. Acceptable manufacturers:
   a. Getinge
   b. Primus

B. Features:

1. Steam source: Integral electric carbon steel steam generator supplied with hot water.
~~2. ProConnect: Remote monitoring~~
~~3.~~ Transfer carriage or dedicated mobile cart.~~.~~
~~4.~~2. Unit equipped with pre-vacuum, gravity and liquid type cycles as standard.
~~5.~~3. Manually operated hinged door, combined with the non-lubricated door seal.
~~6. Integral steam generator.~~

C. Dimensions:

1. Exterior:

   a. Height: 74.5 inches
   b. Width: 30 inches
   c. Depth: 45.63 inches.
   d. Weight: 1230 – 1726 lbs.

2. Interior Chamber Size: 20~~6~~ inches wide, 20~~37-1/2~~ inches high, 38~~48~~ inches long

D. Configuration:

1. Steam source:

   a. Electric carbon steel steam generator supplied with ~~industrial~~ municipal hot water.
2. Doors/installation:
   a. Single door, ~~cabinet enclosed~~ recessed unit.
3. Arrangement: Arrange chamber and service/equipment space as indicated on the drawings.
4. Processes: Prevacuum sterilizers shall be equipped with prevacuum, gravity, liquid, leak test, and daily air removal test cycles. Prevacuum process is for the sterilization of porous and non-porous heat- and moisture-stable goods, sterilization of liquids and media in borosilicate glass containers with vented closures, and decontamination of supplies after laboratory procedures. Prevacuum sterilizers shall be equipped with prevacuum, gravity, liquid, leak test, and daily air removal test cycles.

E. Engineering Data:

1. Sterilizer Feed Water

   a. 1.0" NPT, 30 to 50 psig dynamic.

2. Steam Generator Feed Water

   a. 1" NPT, 50 to 80 psig dynamic, 97% - 100% vapor quality.

3. Drain

   a. 1-1/2" ODT generator drain terminal. (Floor drain capacity must handle peak water consumption; refer to engineering data).

4. Generator Drain terminal.

   a. 2" ODT.

5. Electrical - Controls

   a. 120 Volt, 50/60 Hz, 1-phase, 9.5 Amps.

6. Electrical - Generator

   a. 208 Volt, 50/60 Hz, 3-phase, 83.2 Amps;
   ~~b. 480 Volt, 50/60 Hz, 3-phase, 37 Amps.~~

A. Pre-programmed Cycle Descriptions:

1. Gravity Cycle:

   a. Provide on prevacuum sterilizers for the sterilization of heat- and moisture-stable goods at 212 degrees F to 285 degrees F [100degC to 141degC], and decontamination of bagged laboratory wastes.
   b. Gravity cycle utilizes the gravity air-displacement principle.

2. Liquid Cycle:

   a. Provide on prevacuum sterilizers for the sterilization of liquids and media in vented

borosilicate glass or metal containers at 212 degrees F to 254 degrees F [100degC to 123degC].

b. Liquid cycle utilizes the optimal solution cooling feature, during exhaust cooling phase, to control the exhaust rate.

c. Provide automatic jacket blowdown to exhaust steam from chamber and jacket to prevent liquid loads from boiling over.

3. Prevacuum Cycle:

a. Provide on prevacuum sterilizers for the efficient, high-volume sterilization of porous, heat- and moisture-stable materials at 250 degrees F to 285 degrees F [121degC to 141degC].

b. Prevacuum cycle utilizes a mechanical air-evacuation system

4. Leak Test Cycle:

a. Provide on prevacuum sterilizers for verification of chamber integrity.

b. Cycle parameters shall be preprogrammed and fixed.

c. The acceptable maximum leak rate is 1mm Hg/min over a 10-minute period following a fixed stabilization time.

5. DART (Daily Air Removal Test or Bowie-Dick) Test Cycle: Provided on prevacuum sterilizers to conduct a Bowie-Dick test on the sterilizer.

B. Control system:

1. Manufacturer:

a. Sterilizer manufacturer’s standard microprocessor control system.

2. Controller shall monitor and control all phases of each sterilizing cycle with adjustable cycle values and operation features.

3. Programmed with five default cycles, minimum.

4. Provide completely programmed and documented controls for the unit.

5. Control system shall be housed within a sealed compartment to protect components from moisture and heat generated during sterilization processes. Provide a cooling fan with filter in the housing compartment to maintain positive pressure within the compartment, keeping components cool and dust-free.

6. System shall include help screens for programming and troubleshooting alarm conditions.

7. System shall conduct automatic check on control program and cycle data.

8. Emergency Stop Button shall be located at sterilizer door, returning values to safe condition and halt cycle processing when activated. After activation, operator shall have ability to abort or continue cycle operation.

9. Security Access Codes shall provide restricted access of unauthorized users: The following password levels shall be available:

a. Operator: Permits user to select and start a cycle, acknowledge alarms, view cycle parameters, print reports.

b. Supervisor: Allows user Operator permissions, and ability to edit cycle parameters, edit Proportional Integral Derivative (PID) parameters.

c. Calibrator: Allows user Supervisor permissions, and ability to calibrate instruments.

d. Service: Allows user Calibrator permissions, and ability to view inputs, system diagnosis, activate/deactivate outputs, edit common settings, change date/time.

e. Administrator: Allows user Service permissions, and ability to configure user names and edit passwords.

10. Calibration:

a. Provide for temperature and pressure calibration through the control panel through

the operating end touch screen.

b. Control system shall be capable of providing printed record of all calibration data for comparison to current readings.

11. Operator Interface: Provide at operating (load, non-sterile) end, adjacent to the chamber.

a. Touch-sensitive color screen with graphic display area.

1) Screen shall display sterilizer functions, alarm conditions, and be used for cycle configuration and initiation.
2) Displayed messages shall be in complete phrases with no cross-referenced codes.
3) Screen shall be a minimum of 5 inches by 4 inches [130mm by 100mm].

b. Thermal printer to provide record of all cycle data.

12. Internal Battery:

a. Battery shall be used to back-up all cycle memory for up to ten years.
b. Controller shall require complete restart of cycle upon interruption of power.

C. Construction:

1. Shell assembly:

a. Material: Type 316L stainless steel.
b. Chamber: Welded sterilizer vessel, double walled, and insulated,
c. End Frame: Welded to door end.
d. Vessel (Chamber and Door):.

1) ASME rated at 45 psig [3.12bar] working pressure.
2) Vessel and jacket: Withstand operation from full vacuum to 45 psig [3.12bar] working pressure.

e. Baffle: Provide baffle to shield steam supply opening inside.
f. Passivated internal chamber and door surfaces to maximize corrosion protection.
g. Hinged front cabinet panel to access sterilizer piping and control board housing.
h. Door Assembly/Hinged:

1) Material: Type 316L stainless steel; insulated.
2) Action: Hinged.

a) 26 inch by 37-1/2 inch [660mm by 953mm] chamber.
b) Manually operated, 60 degree turn door handle actuation required to lock or unlock door.

3) Gasket: Replaceable, one-piece, compressible polymer (crush) gasket.
4) Safety: Provide safety lock to prevent door opening when chamber pressure exceeds 2 psi [14 kPa].

2. Insulation:

a. Material: Fiberglass insulation. Insulation shall be asbestos- and chloride-free, silicone impregnated, oil- and water-resistant.
b. Thickness: 1 inch.
c. Insulation sleeve, sealed and held in place with hook–and-loop-type closures. Insulation shall be asbestos- and chloride-free, silicone impregnated, oil- and water-resistant.

3. Piping, Valves, Switches, and Gauges:

a. Piping:

1) General: Brass, including steam strainer, shutoff valve, and brass pressure regulator.
2) Clean/Pure Steam and RO/DI Applications:

a) All piping, valves, regulators fittings, etc. delivering water to the steam source and steam to the chamber shall be stainless steel.

3) All piping connections shall terminate within the confines of the sterilizer.

b. Insulation:

1) Material: Refer to Insulation specification in Division 23 for insulation type.
2) Thickness: Refer to Insulation specification in Division 23 for insulation R-value.
3) Insulate hot and cold piping.

a) Provide vinyl wrap on piping conveying water or steam greater than 100 degrees F [37.7degC].

c. Check Valves: Provide check valves on water feed piping.
d. Backflow Preventer: Provide backflow preventer on water feed piping.
e. Valves:

1) Valves and major components shall be arranged to be easily accessed and replaceable.
2) All valves shall be non-proprietary.
3) Air operated, solenoid valves with lighted DIN connectors, or piston valves located in the manifold.
4) Utility Shut-Off Valves:

a) Provide utility shut-off valves for incoming piped utilities
b) Manual Steam Shutoff:

(1) Pressure-rated at 125 psig [862kPa] for saturated steam.
(2) Valve handles shall be low heat conducting-type.

5) Safety Relief Valve:

a) Provide ASME-certified and labeled safety relief valve (SRV) to protect vessel, jacket, and heat exchanger (where applicable), from pressure build-up beyond the equipment's maximum rated pressure.
b) Coordinate relief valve discharge with Mechanical installer for vent piping to the exterior of the building.
c) Manufacturer shall pipe multiple steam safety relief valves on a unit to a single point for field connection.

6) Pressure Reducing Valves (PRV):

a) Provide pressure reducing valves if incoming steam, water and compressed air pressures need to be reduced to manufacturer-recommend operating pressures.

f. Chamber and jacket pressure gauges:

1) Locations:

a) Service Area.
b) Locate visible to the operator in fascia panel or in service panel adjacent to door.

(1) Provide on each end of double door units.

g. Steam Valve Interlock:

1) Provide steam valve interlock to prevent steam valve from opening when door is open.

h. Pressure Interlock:

1) Provide pressure interlock to prevent opening of door when the unit is above or below atmospheric pressure.

i. Chamber Float Switch Alarms:

1) Provide with chamber float switch to indicate alarm that water is in chamber.

4. Electrical Connections:

a. Provide lighted DIN Connectors.
b. All electrical connections shall terminate within the confines of the sterilizer.

5. Vacuum System:

a. Water ring seal type pump with non-asbestos seal and packing.

1) Install on vibration-isolation mounts.

b. Manufacturer may provide cooling water saving package to reduce water consumption.

1) Initial charge of vacuum pump water shall be cooled and recirculated through a heat exchanger to a break tank, and cool the chamber effluent with a heat exchanger. Tank, recirculation pump, heat exchanger and associated components shall be factory-piped and provided by autoclave manufacturer.
2) Vacuum pump seal water shall be cooled through the use of a heat exchanger and a closed loop chilled water supply, reducing water consumption by approximately 99 percent.
3) Vacuum pump seal water shall be drawn from tank, cooled by heat exchanger to a maximum of 60 degrees F [15.5degC] and delivered to vacuum pump.
4) Tank overflow shall be cooled not to exceed 140 degrees F [60degC] prior to discharge.
5) Tank shall have inlet for cold water make-up.
6) Chilled water will be supplied at temperature not to exceed 42 degrees F and should return from heat exchanger not to exceed 57 degrees F (15 degrees F temperature rise).
7) System shall accommodate incoming chilled water pressures up to 150 psig and shall have a pressure drop not to exceed 5 psig.

D. Features:

1. Resistance Temperature Detectors (RTD): Installed in chamber drain line and chamber jacket to sense and control temperature variations within the chamber and control sterilization process.
2. Jacket Temperature Control: Separate jacket RTD installed in the jacket drain line to allow control of jacket temperature, for optimal cycle performance.
3. Steam Bleed: Constant steam flow supplied across chamber RTD to assure even

temperature distribution and temperature control.

4. Steam Purge: To assist in air removal and to preheat load.
5. RS-485 Interface Port: For downloading cycle information to user-furnished data acquisition system.
6. Electronic Water Saving Control: To control the amount of water used in condensing exhausted chamber steam.
7. Optimal Solution Cooling: To safely cool various liquids in vented, borosilicate glass containers with minimum liquid loss due to boil-over, and to keep normal evaporation loss below 5 percent.
8. Automatic Steam Shutoff to Jacket: For liquid cycles; to allow operation of cycles at lower temperatures and more efficient load cooling.
9. Automatic Utilities Startup/Shutdown:
    a. To shut off utility valves, permitting slow cooling of the entire vessel and load.
    b. Programmed and manual restart options.
10. Control Lockout Switch: Limit switch on chamber door to prevent cycle from starting unless door seal is tight against the door.
11. Chamber Drain System:
    a. To prevent pollutants from entering into the water supply system and sterilizer.
    b. Automatic stainless steel plate-type condensing system to convert chamber steam to condensate and to dispose it to waste.
    c. Provide non-clogging chamber drain line.
12. Provide emergency manual exhaust valve.
13. Effluent Temperature Control System:
    a. System shall not discharge effluent until it has cooled to less than 140 degrees F .
    b. Provide Type 316 stainless steel tank to collapse steam and receive hot effluent for cooling.
        1) Tank shall be equipped with temperature probe and overflow to drain at top.
        2) Hot effluent shall flow into bottom of tank.
        3) Provide cold water for make-up and for cooling if demanded by tank prior to discharging effluent.
        4) Temperature probe shall adjust flow of cold water in to effluent discharge to reduce tank water temperature prior to discharge at overflow only when tank water is 140 degrees F [60degC] or higher.
        5) System shall only require cold water supply. System shall not require power.
14. Gasket: Synthetic neoprene or silicone on sterilizer sub-frame to ensure tight fit between cabinet end panels, and wall partitions, if provided.
15. Utility Requirements: Refer to Laboratory Equipment Schedule.

2.3 ACCESSORIES

A. Loading Car: Welded stainless steel frame with modular shelves. Fixed bottom shelf and adjustable top shelves. Stainless steel load retaining side gates and bearing-mounted wheels.

B. Transfer Carriage: Welded corrosion-resistant tubular steel frame, with height-adjustable loading car tracks on top, stainless steel push bar handle, four casters (two fixed and two swivel), and shelving component storage system.

C. Chamber Track Assembly: Located on floor of Sterilizer Chamber.~~.~~

~~D. Pure steam to chamber piping: Separate steam-to-chamber piping including valves, fittings, etc. shall provide steam to the Sterilizer chamber and shall be constructed of 300 series stainless steel. The piping shall be compression type fittings and tubing. Tube fittings shall interface to the chamber through threaded vessel penetration. The chamber safety valve shall have 316 stainless steel welded parts.~~

~~E. Stainless steel indirect pure steam generator: The Sterilizer shall be equipped with a fully automatically controlled steam-to-pure steam generator, integral to the piping system and capable of providing adequate pure steam for the chamber and load. The unit shall include a vertically mounted tube-sheet type shell and tube heat exchanger, high-pressure feed-water pump, level controls and safety valve. All parts of the generator in contact with feed-water and pure steam shall be made of type 316 stainless steel. Pure steam shall be produced efficiently by utilizing house steam and a purified water supply. The output steam volume and pressure shall be automatically regulated according to demand. Condensate from pure steam generator to be connected to the building condensate return.~~

2.4 FABRICATION

A. Fit joints and junctions between components tightly, in true planes, and to prevent entry of water to collect in component voids. Cap open ends of sections exposed to view.

B. Fabricate work with materials and component sizes, metal gauges, reinforcing anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use. Conceal and weld connections wherever possible.

C. Cleanly and smoothly finish exposed edges of materials including holes and cutouts.

D. Provide reinforcing and attached anchorage for built-in products.

E. Provide holes and connections for work installed under other specification sections.

2.5 INSTALLATION ACCESSORIES

A. General: Manufacturer shall provide all installation accessories required for a functional, hygienic and workmanlike installation. Accessories shall include:

1. Gaskets: Provide synthetic rubber gasket(s) on sterilizer subframe to ensure a tight fit between cabinet panels and/or unit and adjacent partition walls.
2. Sealant: Exterior interfaces between cabinet panels and/or unit and adjacent partition walls shall be sealed by sterilizer installer using approved high-temperature silicon sealant.

B. Cabinet-Enclosed Units:

1. Provide three side fascia panels and louvered top panel to conceal sterilizer body, stand and piping.
2. Provide back cabinet fascia panel on single door, freestanding units where the unit is accessible on all sides.
3. Panel Construction: Nominal 0.050" thick Type 300 stainless steel with #3 brushed finish.
4. Hinge panels for easy access to all components, including the manual gasket retract valve and, where scheduled, the steam generator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions:

1. Prior to installation of steam sterilization equipment, carefully inspect the installed work specified in other Sections and verify that work is complete to the point where this installation may properly commence.
2. In the event of discrepancy, immediately notify the Architect.

B. Examine surfaces designated to receive work for conditions that would adversely affect the finished work.

C. Repair or replace surfaces not meeting tolerances or quality requirements governing substrate construction prior to start of work.

D. Verify that surfaces, prepared openings, or support structures are ready to receive work.

E. Verify field measurements and opening dimensions are as instructed by the manufacturer.

F. Inspect and verify that the required utilities are available, in proper locations and ready for use, prior to equipment installation.

3.2 PREPARATION

A. Coordinate with Divisions 22, 23, 25, and 26 for location, size, and type of mechanical, power and communications services required.

B. Before shipping, equipment shall be cleaned inside and outside, be free of rust, loose scale, and other deposits.

C. Finished surfaces shall be protected to prevent shipping and/or storage damage. Connections, flanges, and couplings shall be protected.

D. Delivery and installation shall be coordinated so that equipment can be positioned in-place prior to installation of door frames of smaller dimension and within the sequence of construction:

E. Contractor shall verify the delivery route through building is adequate for equipment.

F. Equipment shall be securely crated and/or packaged to prevent damage during shipment.

G. Loose parts shipped inside of the unit shall be secured.

H. The vendor shall be responsible for delivery of the unit to the job site, setting the equipment in place, unpacking and reassembly.

I. The vendor shall verify that required utilities are available, in proper locations, and ready for use.

J. Beginning of installation means acceptance of existing conditions by the vendor.

K. Upon unpacking of the equipment, the vendor shall remove debris, crating material and packaging from the location.

L. Work required of other sections prior to installation:

1. Provide building service lines supplying specified pressures and flow rates.
2. Install shutoff valves on service lines.
3. Install fused disconnect switches with lockout in OFF position in electric supply lines near the equipment.
4. Provide illumination of service area, with provision of convenience outlet for maintenance.

3.3 INSTALLATION

A. General:

1. Install equipment in accordance with manufacturer's printed instructions and the reviewed submittals.
2. Installation shall be with manufacturer-certified, -approved, -trained, or -provided personnel.
3. Properly align and position equipment.
4. Manufacturer’s Field Services: Provide manufacturer’s field services to supervise installation.

3.4 FIELD QUALITY CONTROL

A. Start Up Services

1. Test, clean, and adjust equipment and apparatus installed to ensure performance meets specified requirements.
2. Operate each unit and test full range of cycles over a continuous period. Record test data.

3.5 ADJUSTING

A. Adjust and re-test units not meeting requirements.

3.6 CLEANING

A. Packaging and debris and other waste resulting from installation of equipment shall be removed.

B. Clean finished equipment, touch up as required and remove and refinish damaged or soiled areas.

3.7 PROTECTION

A. All equipment shall be protected before, during and after installation. Damage to material due to improper protection shall be cause for rejection.

3.8 DEMONSTRATION

A. Refer to Section Division 01 “Demonstration and Training.”

B. Test equipment prior to demonstration. Ensure equipment, including specified accessories, is operational.

C. Provide demonstration of equipment operation and instruction of Owner's personnel.

D. Demonstrate operating capability of equipment and systems.

E. Include control and safety features, and service and maintenance procedures.

F. Engage services of qualified instructor to instruct and train Owner's operating and maintenance personnel in operation, service, and maintenance of equipment.

END OF SECTION 115319

SECTION 115343 -- LABORATORY SERVICE FITTINGS AND FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Laboratory Service Fittings and Fixtures, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

C. Section includes:

1. Laboratory service fittings, valves, electrical pedestal boxes, and related components.
2. Laboratory sinks.

D. Related Sections

1. Division 12 “Metal Laboratory Casework.”
2. Division 22 – Plumbing.
   a. Work includes but is not necessarily limited to furnishing to the project site for installation by Division 22, laboratory fittings, emergency plumbing fixtures, and fixtures described herein and shown on the Laboratory Furnishings and Equipment Drawings.
   b. Laboratory emergency showers: refer to CRB drawings for schedule and location.
3. Division 26 – Electrical.
   a. Electrical work associated with emergency equipment and benchtop electrical pedestals shall be installed by Division 26.

1.2 UNDIVIDED RESPONSIBILITY

A. Unless specified otherwise, because of special coordination requirements, the scope of work described in this Section shall be provided by the supplier of Division 12 “Metal Laboratory Casework”.

1.3 REFERENCES

A. Work shall conform to the recommended practices for laboratory service fittings and fixtures published by the Scientific Equipment and Furniture Association (SEFA) 7: Fixtures, current version.

B. Emergency plumbing fixtures shall comply with requirements of ANSI Standard Z358.1: American National Standard for Emergency Eyewash and Shower Equipment, current edition.

C. Where identified, service fittings and sinks shall be accessible to the disabled in compliance with the requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations.

D. Emergency plumbing fixtures shall be accessible to the disabled in compliance with the

requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Submit complete materials list, including catalogue data of materials, equipment, and products for Work in this Section.

B. Shop Drawings:

1. Submit complete shop fabrication and installation drawings, including plans, elevations, sections, dimensions, details and schedules.
2. Show relationship to adjoining materials and construction.

C. Samples:

1. Submit two (2) samples of each type of specified finish and color specified.

1.5 INFORMATIONAL SUBMITTALS:

A. Close Out Submittals

1. Operating and maintenance manuals describing operating and maintenance procedures.
2. Maintenance and replacement schedules.
3. Components parts list.
4. Nearest local factory representative for components and repairs.

1.6 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:

1. Work of this Section shall be performed by an organization with five (5) years documented experience specializing in the manufacture of the type of equipment specified, with demonstrated ability to produce the specified equipment of the required quality and quantity for complete installation in a project of this type and size within the required time limits.
2. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.

B. Coordination:

1. Work in this Section requires close coordination with Work in Section 123553, Division 22 Plumbing, and Division 26 Electrical.
2. Coordinate Work to assure an orderly progress in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fittings and fixtures to job site in recommended packaging, with each fitting individually packaged, marked, and scheduled for point of use.

B. Inventory fittings, at job site, verify that type and quantity are correct, and re-package until installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Service fittings and emergency plumbing fixtures shall be specifically designed for laboratory use.

B. Service fittings and emergency plumbing fixtures shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.

2.2 LABORATORY SERVICE FITTINGS

A. Description:

1. Laboratory service fittings specified in this section shall be provided by a single manufacturer.
2. Service fittings shall be specifically designed for laboratory use.
3. Service fittings shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.
4. Provide fittings at locations indicated on the Laboratory Furnishings drawings. Refer to Service Fitting Schedule.
5. Fittings shall be factory tested and shall be supplied with nipples, lock nuts, shanks, etc.
6. Serrated tip fittings shall have 3/8 inch [10mm] IPS thread with the hose end being tapered. Diameter of orifice in serrated tip shall be 1/8 inch [3mm], except where otherwise specified.
7. Turrets shall be brass drop forging of design indicated in details shown elsewhere in the Section and shall be one, two-way, four-way, as required, with 3/8 inch [10mm] IPS female inlet thread for connections.

    a. Units shall be furnished with brass shanks, brass locknuts, and washers.

8. Fittings located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform related appearance, regardless of valve type construction.
9. Flanges shall be brass forging of approved design with 3/8 inch [10mm] IPS female inlet and outlet.
10. Fittings shall have plastic colored service index buttons as specified in this Section.

B. Acceptable Manufacturers:

1. Manufacturer:

    a. (Basis of Design) Water Saver Faucet Co.
    b. Chicago Faucet Company
    c. T + S Brass and Bronze Company

C. Design:

1. Body Profile:

a. Service fittings shall have cylindrical body profiles. Mushroom profile not allowed.

1) Deck-mounted:
a) Water valves shall be provided with integral flange at work surface.
b) Needle, fine control needle, and ball valves shall be provided without deck flanges.

2) Wall/panel-mounted:
a) Water valves shall be provided with wall/panel escutcheon.
b) Needle, fine control needle, and ball valves shall be provided with escutcheon.

3) Overhead-mounted:
a) Water valves shall be provided without flange or escutcheon.
b) Needle, fine control needle, and ball valves shall be provided shall be provided without flange or escutcheon.

2. Handles:

a. Locations designated to be accessible to the disabled (ADA).

1) Water faucets: Wrist-blade handles with screw on index identification discs.
2) Laboratory gases, air and vacuum valves: Ball valves fitted with lever-type handles and screw on index identification discs.

b. Other fittings shall be fitted with color-coded hooded type handles with screw-on index discs.

D. Materials:

1. Service valves, fittings, and accessories: Cast brass with a minimum copper content of 85 percent, except for items which are to be brass forging or bar stock, or are specifically specified to be of another material.
2. Assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles and straight serrated hose ends: Solid brass stock.
3. Replaceable seats, needle cones, valve disc screws and other accessories: Monel or stainless steel alloys especially selected for use intended.
4. Finish: Colored epoxy; refer to Finishes section below for color and requirements.

a. Fume Hood Fittings: Fittings inside fume hoods shall have a colored finish color-coded to match the fitting service index color.

E. Water Valves:

1. General:

a. Water fixtures shall be fully assembled and factory tested.
b. Water valves shall include a renewable unit containing working parts which are subject to wear, including stainless steel or Monel seat, Monel screw and heavy duty seat disk and Teflon packing, and an integral adjustable volume control.
c. Unit shall be capable of being readily converted from compression to self-closing, and vice versa, without disturbing faucet body proper and shall also be capable of being readily converted from water construction to needle valve or steam valve construction having outside packing gland without disturbing faucet body.
d. Unit shall be sealed in valve body with special composition gasket.

1) Metal-to-metal or ground joint type of sealing is not acceptable.

e. Exposed metal shall be finished as specified elsewhere in this Section.

f. Water service fixtures shall satisfy the requirements of ANSI/ASME A 112.18.1M and be certified by the Canadian Standards Association (CSA) under Standard CAN/CSA B.125.M89.
g. Goosenecks shall provide full thread for attachment of anti-splash outlet fittings, serrated tips, and filter pumps.
h. Hot water/cold water gooseneck mixers and wall-mounted cold water goosenecks shall swivel.
    1) Swivel point shall be at turret or at valve level if wall mounted.
    2) Swing joints shall have heavy Teflon type packings.
    3) O rings will not be permitted.
i. Cold water goosenecks at cup sinks shall be rigid.
j. Vacuum Breakers: Provide vacuum breakers for hot and cold water fittings including water fittings at fume hoods. Vacuum breakers shall be in compliance with ASSE Standard No. 1001 and CSA Standard CAN/CSA 864-Series M88.
k. Quick Connects: Provide plug and socket (2-piece) quick connect service fittings for chilled water supply and return fittings, compressed air fittings for pressures greater than 2 bar 30 PSI, and other services as indicated in this Section and on the Laboratory Equipment Drawings.
    1) Acceptable Manufacturers:
        a) Manufacturers:
            (1) Stäubli International AG.
            (2) Water Saver Faucet Co.
        b) Substitutions: Not allowed.

2. Fittings and fixtures designated to be accessible to the disabled (ADA) with operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist.
    a. Force required to activate operable parts shall be 5 pounds [22.2N], maximum.

3. HCW: Bench-mounted, hot and cold water faucet.
    a. Renewable water valves and deck-mounted valve body.
    b. Swing gooseneck with vacuum breaker
    c. Removable non-aerated laminar flow outlet, unless noted otherwise. Outlet should terminate approximately 8-1/2 inches [216mm] above deck.
    d. Threaded mounting with locknut, washer, and coupling nuts.
    e. Adjustable volume control.
    f. Base Product:
        1) See Product Schedule below.
            a) Where indicated, provide ¾ inch hose thread outlet fitting with O-ring. Water Saver BO057.

4. CW1: Laboratory water valve.
    a. Hooded handle with colored plastic index button.
    b. 3/8 inch [9.5mm] IPS female inlet.
    c. 3/8 inch [9.5mm] quick connect fitting with male plug.
    d. Provide mounting flange, all applications:
        1) Provide floating escutcheon for wall mounted applications.
    e. In-line vacuum breaker.
    f. Height of valve shall be 5-1/2 inches [140mm], nominal.
    g. Base Product: See Product Schedule below.

5. PR1: Bench- or deck-mounted, hot and cold water pre-rinse unit.
    a. Deck-mounted cast brass valve body with riser and valve hook.

b. Adjustable wall support bracket.
c. 39 inch [990mm] flexible stainless steel hose.
d. Self-closing valve with insulated handle, locking ring, and rubber-bound, spray-type outlet head.
e. Mounting shank.
f. In-line vacuum breaker
g. Base Product: See Product Schedule below.

F. High Purity Water Valves:

1. General:

a. Suitable for purified water.
b. Components in contact with purified water shall be polypropylene.
c. Valve stem and bonnet shall be brass.
d. Elastomeric diaphragm.
e. Exposed metal shall be finished as specified elsewhere in this Section.
f. Water fixtures shall be fully assembled and factory tested.

G. Fine Control Needle Valves:

1. General:

a. Fully assembled and factory tested at 375 psi [2.59mPa] helium pressure.
b. Action of valve shall be slow compression for fine control under pressure up to 125 psi [2.07mPa] and shall have easily replaceable, subject-to-wear parts.
c. Valve shall be constructed with long taper stainless steel needle and a small orifice stainless steel seat, screwed bonnet with extended heavy-duty threads, and molded TFE stem packing with externally adjustable packing nut.
d. Both needle and seat shall be removable and replaceable.
e. Ultra-fine threads shall provide precise flow control at high working pressures.
f. Provide pressure regulators designed for use with the appropriate service at locations indicated on the Laboratory Furnishing drawings.
g. Exposed metal shall be finished as specified elsewhere in this Section.
h. Needle valves for natural laboratory gas service shall be certified for use with natural gas by the Canadian Standards Association under ANSI Z21.15-1997/CGA9.1-M97.
i. Needle valves in fume hoods shall be mounted on the front panel of the fume hood, with components subject to wear accessible from the exterior face of the hood.
j. Fixture shall be specially cleaned, lubricated, assembled and packaged for use with high purity gases.

2. HPG1: Wall/panel-mounted, straight pattern, fine control needle valve fitting.

a. Provide mounting flange, all applications:
1) Provide floating escutcheon for wall mounted applications.

b. Quick connect fittings.
1) Length of valve from wall to quick connect fitting shall be 7-5/8 inches, nominal.

c. Mounting shank assembly for panel installations, only.
d. Pressure regulator.
e. In-line ball valve, operated by Allen wrench, to facilitate fitting service.
f. Base Product: See Product Schedule below. with colored plastic hooded handle with colored plastic index button and outlet appropriate for gas service.

H. Service Fitting Color Index: for colored plastic index buttons:

Service Name	Disc Color	Letters	Letter Color
Lab Air	Orange	AIR	Black
Compressed Air	Orange	AIR60,90,100	White
Vacuum	Yellow	VAC	Black
Industrial (Laboratory) Cold Water	Dark Green	ICW	White
Industrial (Laboratory) Hot Water	Red	IHW	White
Cold Water (Potable)	Dark Green	CW	White
Hot Water (Potable)	Red	HW	White
Nitrogen	Brown	N2	White
Carbon Dioxide	Pink	CO2	Black
Helium	Black	HE	White
Oxygen	Light Green	O2	Black
SPG (95/5 Mix)	Light Blue	SG	Black

2.3 LABORATORY SAFETY EQUIPMENT

A. Description:

1. Laboratory safety equipment shall be specifically designed for laboratory use.
2. Laboratory safety equipment shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.

B. Acceptable Manufacturers:

1. Laboratory safety fixtures specified in this section shall be provided by a single manufacturer.
2. Manufacturers:
   a. Guardian Equipment.
   b. Haws Corporation.
   c. Speakman Company.
   d. Water Saver Faucet Co. (Basis of Design)

C. General:

1. Provided products shall satisfy the identified requirements, characteristics, and features as specified herein.
2. Laboratory safety equipment shall be certified in accordance with ANSI Z358.1, current edition.
3. Recessed cabinet in concrete masonry unit walls shall be fabricated so that piping does not interfere with the block face shell (outer wall).

D. DH: Dual-purpose eye wash/drench hose, deck mounted.

1. Basis for design: See Product Schedule below.
2. Dual-purpose eye wash/drench hose unit with dual gentle spray outlet heads and squeeze handle/valve with locking clip.
3. Heads shall be equipped with flip top dust cover that automatically releases with water pressure.
4. Flexible, reinforced PVC hose shall be furnished with swivel fitting at inlet end.
5. Furnish with in-line backflow preventer at the hose inlet.
6. Mounting flange and squeeze valve shall be color epoxy coated.

7. Mounting shank.

2.4 FINISHES

A. Colored Epoxy Finish:

1. Applicable to:

   a. Laboratory service fittings, except for fittings specified to receive a different finish.

2. Preparation:

   a. Surfaces to be coated shall be polished to a uniform fine-grained surface and cleaned with a phosphoric acid solution to thoroughly remove oil, grease and other foreign substances.

3. Epoxy Finish:

   a. Following cleaning, coating material shall be electrostatically applied to exposed surfaces.
   b. After application, coating shall be fully baked to permit curing.
   c. Surfaces shall have a minimum finished coating thickness of 3 mils [76µm].
   d. Coating material shall be free-flowing epoxy powder with particle size of 35 to 70 microns.

4. Color:

   a. Black, final color to be selected by architect
   b. Fittings inside fume hoods shall have a colored finish color-coded to match the fitting service index color.

B. Performance requirements for coated finishes:

1. Chemical resistance:

   a. Fume Test:
      1) Suspend coated samples in a container of at least 6 cubic feet [170L] capacity, approximately 12 inches [300mm] above open beakers, each containing 100ml of 70 percent nitric acid, 94 percent sulfuric acid and 35 percent hydrochloric acid, respectively.
      2) After exposure to these fumes for 150 hours, the finish on the samples shall show no discoloration, disintegration or other effects.
      3) Direct Application Test:
      4) Subject coated samples to the direct action of the following reagents and solvents at a temperature of 25degC dropping from a burette at the rate of 60 drops per minute for ten minutes.
      5) Finish on samples shall not rupture, though slight discoloration or temporary softening is permissible.

Reagent	Concentration
Acetic Acid	98%
Acetone	
Ammonium Hydroxide	28%
Amyl Acetate	
Amyl Alcohol	
Benzene	
Butyl Alcohol	
Calcium Hypochlorite	

Reagent	Concentration
Carbon Disulfide	
Carbon Tetrachloride	
Chloroform	
Chromic Trioxide Acid	
Cresol	
Crude Oil	
Dioxane	
Distilled Water	
Ether	
Ethyl Acetate	
Ethyl Alcohol	
Ethyl Ether	
Formaldehyde	37%
Formic Acid	90%
Gasoline	
Glacial Acetic Acid	99.5%
Glycerine	
Hydrochloric Acid	38%
Hydrofluoric Acid	48%
Hydrogen Peroxide	5%
Isopropyl Alcohol	
Lactic Acid	10%
Kerosene	
Methanol	
Methyl Alcohol	
Methyl Ethyl Ketone	
Methylene Chloride	
Mineral Oil	
Monochlor Benzene	
N-Hexane	
Naphthalene	
Nitric Acid	70%
Perchloric Acid	70%
Phenol	
Phosphoric Acid	75%
Sea Water	
Silver Nitrate	30%
Sodium Bichromate	saturated
Sodium Carbonate	10%
Sodium Chloride	20%
Sodium Hydroxide	50%
Sodium Hypochlorite	
Sodium Sulfide	
Sulfuric Acid	87%
Toluene	
Trichlorethylene	
Turpentine	
Urea	saturated
Xylene	
Zinc Chloride	saturated

2. Mar and abrasion resistance:

   a. Coating material shall have a pencil hardness of 2H – 4H with adhesion substantial

enough to withstand both direct and reverse impacts of 160 inch-pounds [18 Nm].

b. Coating shall have excellent mar resistance and be capable of withstanding scuffing, marring and other ordinary wear.

3. Reparability:

a. Scratches and other localized surface damage shall be field-repairable.

2.5 LABORATORY SINKS

A. General:

1. Inside dimensions of sink bowl are provided on drawings.
2. Provide tailpiece compatible with waste piping system for sinks unless otherwise specified.

a. Refer to Division 22 for piping requirements.

B. Epoxy Resin:

1. Acceptable Manufacturer: Manufacturer shall be the manufacturer of the epoxy resin work surfaces specified in Section 123553.
2. Dimensions: Refer to Sink Schedule on Drawings.
3. Material: Comply with the requirements of Section 123553 for epoxy resin.

a. Color: Black, final color selection to be chosen by architect from manufacturers standard color selection.

4. Features/Characteristics:

a. Laboratory Sinks:

1) Mounting: Refer to Sink Schedule on Drawings.
2) Sink installation shall be performed under Division 12 in epoxy resin work surface.
3) Exposed edges shall be radiused not less than 1/4 inch [6mm].
4) Tops without drain grooves: Sink shall be set 1/8 inch [3mm] below the level of the adjacent surface.
5) Provide epoxy resin sink outlet with strainer, stopper and open-end overflow, and install in sink with continuous bead of silicone sealant.

C. Stainless steel:

1. Laboratory Sinks, integral with stainless steel work surface:

a. Materials: Refer to Section 123553, Stainless Steel Fabrications for stainless steel requirements.

b. Features/Characteristics:

1) Provide stainless steel strainer, outlet, standpipe overflow and stopper for sinks unless otherwise specified.
2) Provide tailpieces compatible with waste piping system for sinks unless otherwise specified. Refer to Division 22 for piping requirements.
3) Undercoating: Waterborne and non-flammable in liquid state, with no volatile organic compounds (VOCs) providing sound deadening and preventing condensation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation of fixtures specified in this section, carefully inspect the installed Work specified in other Sections and verify that Work is complete to the point where this installation may properly commence.

B. Verify that Work has been installed in complete accordance with the original design, approved submittals, and the manufacturer's recommendations.

C. Discrepancies:

1. In the event of discrepancy, immediately notify the Architect.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

B. Clean and flush supply lines prior to installation of faucets, valves, and safety equipment.

3.3 INSTALLATION

A. General:

1. Install fixtures plumb and level.
2. Use Teflon tape of pipe sealant to seal threaded connections.
3. Provide piping connections to fixtures with valves and escutcheons as specified in Division 22.
4. Verify that fixtures and trim are tight, leak-free and function properly

B. Sinks: Set sinks in chemical resistant sealing compound, secure and support, as recommended by the manufacturer.

C. Safety Stations, Emergency Showers, and Emergency Eyewash:

1. Emergency showers must be installed with a minimum of 16 inches [407mm] of clearance from obstruction to the center of the showerhead.

   a. Eyewash or eye/face wash fixture is not considered an obstruction.

2. Install emergency showers with showerhead positioned not lower than 82 inches or above 96 inches measured from the operational standing surface.

   a. Refer to drawings for mounting height within that range.
   b. If no range is provided, shower head shall be installed 96 inches above operational standing surface.

3. Recessed wall cabinets in fire rated partitions shall be installed in accordance with UL approved design.

D. Hose Reels:

1. Manufacturer shall confirm weight of hose reel assembly when hose is filled with water.
2. Structural Support:

   a. Framed walls and partitions:

1) Provide slotted channel framing between structural flooring and structural deck above in the wall or partition construction to support hose reel assembly.
2) Framing shall be designed to support live load of hose reel assembly.

b. Concrete Masonry Walls:
1) Grout concrete masonry solid to support hose reel assembly.

3. Provide masonry anchors as recommended by manufacturer to support live load of hose reel assembly.

3.4 FIELD QUALITY CONTROLS

A. Review conditions of installation, procedures and coordination with related Work.

B. Carefully inspect the installed Work specified in other Sections and verify that Work is complete and ready for the installation of this Work to properly commence.

C. Verify that Work may be installed in complete accordance with the original design, reviewed submittals and manufacturer's recommendations.

3.5 ADJUSTING

A. Set internal volume control on cup sink water fittings so water does not splash out of sink.

3.6 CLEANING

A. Clean service fittings and fixtures with a soft cloth and soapy water or as recommended by the manufacturer. Do not use abrasives, detergents, or other cleaners. Do not use solvents in or around a faucet or valve.

3.7 PRODUCT SCHEDULE

TAG ON QL PLANS	DESCRIPTION	MANUFACTURER BOD	MODEL	ALTERNATIVE	Mounting
Sinks					
SK-1	Epoxy Sink	Durcon	D58		Drop-in
SK-2	Stainless Steel ADA Sink (Basin 1 = 24 x 15 x 5.5, Basin 2 = 18 x 15 x 17.75)				Drop-in
SK-3	Stainless Steel Scullery Sink	Elkay	RNSF8236LR2		Floor
CS-1	Epoxy Cupsink				
Mixing Faucets					
HCW-1	Deck mounted mixing faucet with vacuum breaker, 6” swing gooseneck, aerator and wrist blade lever handles. Lead Free	WaterSaver	CT2224VB	Chicago Faucet (786-GN8BVBE7CP)	Deck
HCW-2	Deck mounted mixing faucet with vacuum breaker, 8” swing gooseneck, aerator and wrist blade lever handles. Lead Free	WaterSaver	CT2224VB-8	Chicago Faucet (786-GN8BVBE7CP)	Deck
HCW-3	Pre-Rinse Fixture for Scullery Sink	WaterSaver	CTPR1711-110WS-BH	510-GC613AL12ABCP	Wall/Panel
Water Valves					
HPW-1	Deck mounted polypropylene-lined pure water faucet with toggle-style lever handle and combination manual / self-closing control.	WaterSaver	CT7833MSC		Deck
HPW-2	Panel mounted polypropylene-lined pure water faucet with toggle-style lever handle, combination manual / self-closing control, and 8” spread gooseneck.	WaterSaver	CT7840MSC8		Panel
HR-1	Hose Reel	Chicago Faucet	535-NF		Wall

CW-6	Remote control assembly with panel mount water valve for straight face fume hood (CT740W), panel mounted body with 6” rigid vacuum breaker gooseneck with removable serrated hose end in hood (CT071VB-WSA). Combined assembly ordered as CT740W-9VB. Coordinate with Fume Hood manufacturer.	WaterSaver	CT740W-9VB		Panel/Fume hood
Safety Equipment					
EW-1	Deck mounted eyewash/drench hose unit with dual soft stream heads operated by a self closing squeeze lever with a locking clip, and in-line backflow preventer. 8ft long high pressure hose with flange and handle guide for mounting through casework. Undercounter hose guide bracket.	WaterSaver	EW1022BP-HG		Deck
EW-2	Deck mounted barrier-free 90 degree swing down eyewash with dual soft stream heads operated by swinging the fixture down to operational position.	WaterSaver	EWBF849LH-R (right) EWBF849L (left)		Deck
EW-3	45-degree panel mounted eyewash/drench hose unit with dual soft stream heads operated by a self closing squeeze lever with a locking clip, and in-line backflow preventer. 8ft long high pressure hose with flange and handle guide for mounting through casework.	WaterSaver	EW1041BP		Panel

SS/EW-1	Wall mounted recessed safety station with barrier-free eye/face wash and safety shower, exposed shower head, and drain pan with daylight drain on front of cabinet. Include option for electric light and alarm horn.	WaterSaver	SSBF2172-AP280-235		Wall - Recessed
SS/EW-2	Surface mounted recessed safety station with barrier-free eye/face wash and safety shower, exposed shower head, and drain pan with daylight drain on front of cabinet. Include option for electric light and alarm horn.	WaterSaver	SSBF2173-AP280-235		Wall - Surface Mount
Gas Ball Valves					
LA, LV, LG-1	Wall mounted single laboratory ball valve with removable serrated hose end and lever handles.	WaterSaver	CT4200-158FT		Wall
LA, LV, LG-2	Wall mounted double laboratory ball valve (90 degree between valves) with removable serrated hose ends and lever handles.	WaterSaver	CT4200-141FT		Wall
LA, LV, LG-3	Panel mounted double laboratory ball valve (90 degree between valves) with removable serrated hose ends and lever handles.	WaterSaver	CT4200-158WSA		Panel
LA, LV, LG-4	Deck mounted single laboratory ball valve with removable serrated hose end and lever handles.	WaterSaver	CT4200-231WSA		Deck
LA, LV, LG-5	Deck mounted double laboratory ball valve (180 degree between valves) with removable serrated hose ends and lever handles.	WaterSaver	CT4200-232SWSA		Deck
LA, LV, LG-6	Remote control assembly with panel mount ball valve for straight face fume hood (CT740), 45 degree panel mount outlet fitting in hood with removable serrated hose	WaterSaver	CT740-LR		Hood

	end (CT022WSA). Combined assembly ordered as CT740-LR. Coordinate with Fume Hood manufacturer.				
Gas Needle Valves					
SG-1	Wall mounted double laboratory needle valve (90 degree between valves) with removable serrated hose ends and nylon hooded handles. Cleaned for high purity gases.	WaterSaver	CT4880FT-325		Wall
SG-2	Wall mounted double laboratory needle valve (90 degree between valves) with removable serrated hose ends and nylon hooded handles. Cleaned for high purity gases.	WaterSaver	CT2880-141FT		Wall
SG-3	Panel mounted double laboratory needle valve (90 degree between valves) with removable serrated hose ends and nylon hooded handles. Cleaned for high purity gases.	WaterSaver	CT2880-141WSA		Panel
SG-4	Deck mounted single laboratory needle valve with removable serrated hose ends and nylon hooded handles. Cleaned for high purity gases.	WaterSaver	CT2880-231WSA		Deck
SG-6	Remote control assembly with panel mount needle valve for straight face fume hood (CT740N), 45 degree panel mount outlet fitting in hood with removable serrated hose end (CT022WSA). Combined assembly ordered as CT740N-LR. Cleaned for high purity gases. Coordinate with Fume Hood manufacturer.	WaterSaver	CT740N-LR		Hood
Gas Pressure					

Regulator Fixtures					
CO2-2	Wall mounted double pressure regulator fixture with non-relieving regulators, guages, lever handle ball valves, quick connect outlet fittings. For low pressure point-of-use regulation of carbon dioxide supplying CO2 to incubators.	WaterSaver	CT4203-364EL-179FT		Wall
CA-22a	Basis of design products by Division 22. Wall/panel mounted fine control needle valve fitting for high pressure gas. Provide mounting flange, floating wall escutcheon (at wall applications), pressure regulator with guage, in-line ball valve operated by allen wrench, quick-connect fittings.	By Div. 22			
CA-22b	Basis of design products by Division 22. Panel mounted fine control needle valve fitting for high pressure gas. Provide mounting flange, pressure regulator with guage, in-line ball valve operated by allen wrench, quick-connect fittings. Provide overhead mounted hose reel with minimum 25ft length, automatic locking and winding system and quick connect fittings.	By Div. 22			

END OF SECTION 115343

SECTION 115353 -- BIOLOGICAL SAFETY CABINETS CLASS II A2

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Work Included:

1. Contractor is responsible for preparing the spaces to receive the BSC; all utilities should be stubbed to the appropriate locations noted on BSC supplier's shop drawings.
2. Contractor shall connect BSC piping to building exhaust and piped systems at a single point for each utility. Installation of connection to building exhaust and piped utilities is the responsibility of the Contractor and is specified in Division 23.
3. Internal piping shall be factory installed.

B. Related Sections:

1. Division 12 Section "Laboratory Casework."
2. Division 22- Furnishing and installation of plumbing utilities and final connections.
3. Division 23- Furnishing and installation of exhaust ductwork and equipment, and final connection of facility-exhausted biological safety cabinets.
4. Division 23 - Testing, Adjusting, and Balancing" for field quality-control testing.
5. Division 26 - Furnishing and installation of electrical utilities and final connections to fume hoods.

1.3 REFERENCES:

A. NSF/ANSI 49 – 2004

B. CDC/NIH: Primary Containment of Biohazards: Selection, Installation and Use of Biological Safety Cabinets - 1995

C. UL - Underwriters Laboratories

1.4 PERFORMANCE REQUIREMENTS

A. Containment: Provide biological safety cabinets that comply with the performance requirements of NSF/ANSI 49 – 2004.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Submit complete materials list, including manufacturer's brochures and catalog data of materials, equipment, and products for Work specified in this Section. Also provide the following

1. Certificates:

   a. Certify that factory and field tests have been performed and that work meets or exceeds specified requirements.
   b. Certify that each unit meets or exceed requirement of National Sanitation Foundation Standard #49.
   c. Factory Test Results: Each Biosafety Cabinet shall be factory tested according to NSF/ANSI 49 2004 Annex A. Certification documentation shall be submitted within 30 days of shipment.

2. Start-up Report.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Indicate dimensioned locations and types of facility exhaust and service fittings together with associated service supply connection required.

   2. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from above items.

C. Samples for Verification: For factory-applied finishes interior lining and countertop material, in manufacturer's standard sizes.

1.6 INFORMATION SUBMITTALS

A. Qualifications: Contractor to submit evidence that installer and manufacturer meets the requirements specified herein.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For BSC to include in emergency, operation and maintenance manuals. In addition to items specified in Division 1 Section “Operating and Maintenance Data,” include the following:

   1. Equipment manuals describing operating procedures, maintenance and replacement schedules, including wiring diagrams, component parts list with recommended spares, and factory-authorized service agency closest to the Project contact information, including phone number for emergency repairs.

B. User Training

   1. Before occupancy by laboratory staff, the BSC supplier shall furnish a workshop on appropriate BSC operating and routine maintenance techniques and allow this workshop to be videotaped for use in ongoing user training. This workshop shall be conducted by a BSC specialist specifically authorized by the manufacturer to perform such training.

   2. Contractor shall videotape the training described in the subsection above and include 2 copies of this video in the project closeout documentation.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Firm shall be regularly engaged in the installation of products specified in this Section, with a minimum of five (5) years of experience.
2. Firm shall be manufacturer "licensed" or "approved" for installing specified Products.
3. Installers Firm shall utilize only manufacturer "licensed" or "approved" installers for installing specified Products.

B. Manufacturer Qualifications:

1. Manufacturer shall be ISO 9002 certified for the herein specified Products, or regularly engaged in the manufacture of products specified in this section, whose products have been in satisfactory use, under similar service conditions, for not less than five (5) years.
2. Installer Quality Assurance Program: Firm shall have an established program for installer quality assurance. Program shall include, but not be limited to, initial and continued installer training, and initial and continued installer evaluation, and "licensing", "approval", or other form of certification of installers.
3. Single source responsibility: Products specified under this section shall be manufactured by a single manufacturer.

C. Manufacturer Supervision:

1. Manufacturer shall directly supervise the application of specified Products.

2. Supervision shall include, but not be limited to, the following receiving, storage, handling of Product necessary for the installation, repair, or removal of the Product; and Product installation, and removal, if required; and Product repair, if required.

D. Source Quality Control: Products shall be tested and listed by a Nationally Recognized Testing Laboratory (NRTL) as applicable, including, but not limited to:

1. American Gas Association (AGA).
2. Canadian Standards Association (CSA).
3. ETL Testing Laboratories, Incorporated (ETL).
4. ETL Testing Laboratories of Canada, Incorporated (ETL-C).
5. NSF International (NSF).
6. Underwriters Laboratories, Incorporated (UL).
7. Underwriters Laboratories of Canada, Incorporated (UL-C).

E. Product Designations: Specifications and drawings indicate types of Biosafety Cabinets.

F. Safety Glass: Products complying with testing requirements in 16 CFR 1201 for Category II materials.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Pre-installation Conference: Conduct conference at Project site to comply with requirements specified in Division 1.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

B. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

C. Protect top surface throughout construction period with 1/4" corrugated cardboard completely covering the top and securely taped to edges. Mark cardboard in large lettering "No Standing".

1.10 PROJECT CONDITIONS

A. Do not deliver or install equipment until the following conditions have been met:

1. Windows and doors are installed and the building is secure and weather tight.
2. Ceiling, overhead ductwork and lighting are installed.
3. All painting is completed and floor covering located below BSC is installed.
4. Utility roughing-in for BSC is complete.
5. HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate installation of BSC with installation of doors and frames, laboratory casework, and plumbing and electrical work.

1. Prior to BSC installation, contractor shall verify that locations and sizes of mechanical exhaust connections for hard-ducted, and similar BSCs are installed in accordance with the approved BSC shop drawings. All exposed ductwork serving BSCs shall be dropped vertically without bends or size transitions.

1.12 EXTRA MATERIALS

A. Furnish complete touchup kit for each type and color of hood finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged hood finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Products: The design for Biosafety Cabinets and associated components is based on the manufacturers and products named in Part 2 Articles. Subject to compliance with requirements, provide the named product or a comparable product by one of the acceptable manufacturers.

B. Manufacturers and Products:

1. Baker;
2. NuAire, Inc

3. Labconco;

2.2 BIOSAFETY CABINET, CLASS II, TYPE A2, FULLY RECIRCULATING

A. Biological safety cabinets designed to discharge HEPA-filtered exhaust air directly into the laboratory. Biosafety levels 1 or 2.

B. (Basis of Design) Baker; “SterilGARD SG604.”

C. Product Characteristics:

1. Overall Dimensions: Refer to drawings.

2. Engineering Data:

a. Vacuum.
b. All BSC will require additional amperage than the standard unit. Each will have two plugs one for the fan and lighting and the other will be to power the 2 electrical duplex outlets with 110V 20A total power.

D. Features:

1. Ultra-violet lamp option
2. Air flow monitor
3. Ergonomic footrest
4. Telescoping legs
5. 2 petcocks
6. Operational sash height 10".
7. Front filter replacement
8. 12' power cord plug

E. Unit shall be designed with HEPA filtered down flow air and HEPA filtered exhaust air returned to room.

F. Cabinet exterior construction shall be 16 gauge cold rolled steel, with baked enamel finish.

G. Cabinet Interior shall be one piece 16 gauge type 304 stainless steel, NAAMM No.4 finish, side walls, rear wall and work surface with 3/16” radius corners. Provide slotted side walls adjacent to front access opening for high velocity return air. Cabinets shall have a drain pan with a 7/16” radius on all sides and a fully removable work surface and work surface support to facility cleaning. Sealant joints are not permitted. Provide welded, gasketed and or hermetically sealed joints for cabinet components to achieve a gas tight seal when completely assembled. Provide hinged view screen with ¼” thick safety plate glass with high velocity suction slots at top and sides to prevent escape of gases, vapors or particulates. View screen shall be adjustable form fully closed to 18 inches open. Provide all metal air plenums. There shall be a stainless steel air diffuser and filter protector in the top of the work area.

H. Unit shall be designed to directly exhaust a portion of the total volume of air handled in the unit from the work surface area.

I. Motor/blower system shall be capable of delivering over 80% of the initial HEPA filter static pressure with no more than a 10% decrease of CFM. Speed controller shall automatically compensate for voltage change to maintain constant voltage to motor.

J. The unit shall have one supply and one exhaust scan tested, zero-probe HEPA filter (99.9% efficient on 0.3 micron particles by DOP test. Filters and blower shall be removable from the front without entry into the work space; bag-in bag-out filters are required.

K. Plenum area to be stainless steel; flexible bags are not permitted.

L. Provide a manual damper assembly to prevent leakage of gas during decontamination.

M. Air velocity through an eight high work opening shall be 100-110 fpm.

N. 10” sash (viewscreen) shall be counterbalanced by a stainless steel cable.

O. Rear wall corners of work area and joints of wall to work surface shall be coved, continuously welded and ground smooth and polished to remove grain.

P. Provide vertically adjustable support stand; countertop height should have a range from 30”-36” above finished floor.

Q. Audible and visible alarm system shall be provided to indicate low exhaust airflow. Silencer for the audible alarm shall be provided for 5 minutes of temporary silence, visual alarm shall remain activated. Alarms will be tied into the building automation system.

R. Complete unit shall be listed as certified by Underwriters Laboratory (UL) for electrical safety and integrity.

S. Provide 80 footcandles lighting at the worksurface; remote ballast is required.

T. A two power cord shall be provided for electrical power source; coordinate with Electrical installation of outlets. Each will have two plugs one for the fan and lighting and the other will be to power the 2 electrical duplex outlets with 110V 20A total power to duplexes.

U. Seal electrical connectors from the sealed areas of the cabinet.

V. Plumbing Fittings:

1. Provide manufacturer’s sidewall-mounted standard petcock(s) with exterior connections pre-piped through bottom of unit for connection to utilities from below for each piped service indicated on the Drawings. Provide NPT male connections with caps extending 4 inches minimum below underside of cabinet. Mount petcocks on side of cabinet adjacent to casework or wall mounted petcocks. (See drawings for locations).

2. Provide standard blank-outplugged penetrations for future fittings, plugs must be sealed gas tight.

2.3 MATERIALS

A. Steel Sheet: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 924/A 924M and ASTM A 653/A 653M, phosphatized, minimum spangle, Z120 (G30) zinc-coated (galvanized) both sides, commercial quality, cold-rolled, sheet with other parameters selected by manufacturer and as specified herein.

C. Stainless-Steel Sheet: ASTM A 666, Type 304; stretcher-leveled standard of flatness.

D. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality q3.

2.4 MECHANICAL, MISCELLANEOUS

A. Provide all piping, valves, boxes, controls, connections, and accessories as indicated on the Drawings, and as required by the Product Data, Shop Drawings, Installation, and Operation and Maintenance Instructions; or if not indicated or required, as necessary for a complete installation.

2.5 ELECTRICAL, MISCELLANEOUS

A. Provide all wiring, conduit, boxes, controls, connections, and accessories as indicated on the Drawings, and as required by the Product Data, Shop Drawings, Installation, and Operation and Maintenance Instructions; or if not indicated or required, as necessary for a complete installation. Provide 110V electrical outlets on each side of the inside of the BSC.

2.6 BLOCKING AND BACKING

A. Provide all blocking and backing as indicated on the Drawings, and as required by the Product Data, Shop Drawings, Installation, and Operation and Maintenance Instructions for a complete installation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of laboratory hoods.

B. Verify that the surrounding Work is complete, and adequate for the installation of BSC.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate all mechanical Work with the Division 23 - Mechanical Work, and all electrical Work with the Division 26 - Electrical Work.

3.3 START-UP OF BIOLOGICAL SAFETY CABINETS

A. General: Provide Start-Up Services.

1. Services shall include, but not limited to, manufacturer's recommended start-up, testing, calibration, and maintenance procedures; and specified start-up, testing, and calibration procedures.

B. Start-Up Prerequisites:

1. Electrical power and lighting specified herein and in Division 26 - "Electrical" shall be commissioned, tested, and accepted by the Owner.
2. Building Automation System (BAS) shall be commissioned and tested, except for Work directly requiring operational BSC and BSC controls.
3. HVAC systems shall be commissioned, tested, and adjusted as specified in Division 23 Section "Testing, Adjusting, and Balancing", except for Work directly requiring operational BSC and BSC controls.
4. The above are condition precedents for the start-up, testing, and balancing of the hoods.

C. Start-Up: Start-up BSC in accordance with manufacturer's Installation Instructions, Operation and Maintenance Instructions and in coordination with the start-up and commissioning of the BAS and HVAC systems, and as specified.

1. BSC shall be fully operational and coordinated with the BAS and HVAC systems at the end of BSC Start-Up.

D. Field Testing and Certification:

1. Manufacturer shall retain an independent testing agency to provide field testing and certification according to NSF/ANSI 49 Annex F including the following as applicable to the type of cabinet
   a. Downflow velocity test using the same method as used for factory certification
   b. Inflow velocity using either a DIM device or face velocity profile as adjusted per factory certification
   c. Airflow smoke pattern test
   d. HEPA Filter Leak Test
   e. Cabinet Integrity tests on A1 Cabinets
   f. Site installation assessment tests
      1) Alarming functions
      2) Blower Interlock
      3) Exhaust System Performance.

2. Provide certification documentation both in bound report including testing of all cabinets as well as a separate copy safely and securely attached to the cabinet.

E. BSC shall be operating for a minimum of ten (10) calendar days prior to Final Acceptance and/or Substantial Completion, whichever occurs first.

F. Sequence of start-up and certification:

1. Contractor installs cabinet.
2. Manufacturer starts up cabinet and ensures all aspects are checked and are operational.
3. Cabinet is turned off to preserve HEPA filters
4. Exhaust flow is balanced with fan turned on only where necessary.
5. Cabinet and Room are functionally tested
6. Independent Agency certifies the cabinet for final use during Endurance Period.

3.4 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

3.5 PROTECTION OF FINISHED WORK

A. Provide all necessary protective measures to prevent exposure of equipment to other construction activity.

B. Biosafety supplier shall advise Contractor of procedures and precautions for protection of material and installed fume hoods from damage by work of other trades.

3.6 DEMONSTRATION AND TRAINING

A. Demonstration and training shall be completed prior to Substantial Completion and Owner's acceptance of operation and maintenance of the BSC.

B. Demonstration: Demonstrate hood operation to Owner's designated personnel.

1. Demonstrations shall consist of instruction on the basic function and operation of equipment to non-technical Owner employees.
2. Demonstrations shall be conducted in the "field", using the actual equipment or systems to be operated.
3. Demonstrations shall include, but shall not be limited to, "what to do" (correct operation of the equipment or system), "what not to do" (incorrect operation of the equipment or system), and "when to call maintenance" (recognizing incorrect operation of the equipment or system failure.

C. Training: After completion and acceptance of work, provide a minimum of eight (8) hours of instruction and hands-on training for Owner's operating and maintenance personnel, in the operation, adjustment, and maintenance of the BSC.

END OF SECTION 115353

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. **WT01:** Motor-operated Solar roller shades with single rollers as indicated.

2. **WT02:** Motor-operated Solar & Blackout roller shades with double rollers as indicated.

3. **WT03:** Motor-operated Blackout roller shades (Only) with single roller as indicated.

~~3.~~4. **WT04**: Single Roller Window Shade (Solar) Floor Mounted.

B. Related Sections include the following:

1. Division 05 Section "Decorative Formed Metal" for custom sheet metal pockets for window treatments.
2. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
3. Division 26 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized shade operation.

1.3 ACTION SUBMITTALS

A. Submit in accordance with provisions stated in Division 01 Section “Submittal Procedures.”

B. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

A. Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members and attachment to building structure.
2. Shade mounting assembly and attachment.
3. Size and location of access to shade operator, motor, and adjustable components.
4. Minimum Drawing Scale: 1/4 inch = 1 foot.

B. Samples for Verification:

1. Complete, full-size operating unit not less than 16 inches wide for each type of roller shade indicated.

2. Shade Material: Not less than 12-inch square, with specified treatments applied. Mark face of material.

C. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.

1.4 INFORMATION SUBMITTALS

A. LEED Informational Submittals: to be decided.

B. Safety and stewardship information about the chemical ingredients is publicly available from all points along the supply chain.

C. Product Certificates: For each type of roller shade, signed by product manufacturer.

D. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:

1. Methods for maintaining roller shades and finishes.
2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
3. Operating hardware.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Source Limitations: Obtain roller shades through one source from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701.
2. Insert fire-test-response characteristic: Insert fire-test-response requirements and test method.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Product Standard: Provide roller shades complying with WCMA A 100.1.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 WARRANTY

A. General: Submit a written warranty agreeing to repair or replace operable shade system, chains, fabrics and related accessories which have failed due to faulty materials or workmanship. The warranty shall be signed by the manufacturer and the installer.

1. Warranty Period: Three (3) years from date of substantial completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Rollers Shades: Before installation begins, for each size, color, texture, and pattern indicated, full-size units equal to 1 percent of amount installed.

PART 2 - PRODUCTS

2.1 WT01: MOTORIZED SOLAR SHADE MANUFACTURERS

A. Manufacturers providing products in compliance with requirements include but are not limited to the following:

1. (Basis of Design): MechoShade Systems, Inc.; Electro series.
2. Nysan Shading Systems, Ltd.
3. Silent Gliss USA Inc.
4. Or equal.

B. Product: (Model 4133)

1. Shade Cloth: Visually Transparent Single-Fabric Shadecloth with light transmittance to be less than 3% (<3%).
   a. Mechoshade "Thermoveil" or "Euroveil"
      1) Single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl.

2.2 WT02: MOTORIZED SOLAR & BLACK-OUT SHADE MANUFACTURERS

A. Manufacturers providing products in compliance with requirements include but are not limited to the following:

1. (Basis of Design): MechoShade Systems, Inc.; Electro series.
2. Nysan Shading Systems, Ltd.
3. Silent Gliss USA Inc.
4. Or equal.

B. Product: (Electro Model 5113)

1. Shade Cloth #1: Visually Transparent Single-Fabric Shadecloth with light transmittance to be less than 3% (<3%).
   a. Mechoshade "Thermoveil" or "Euroveil"
      1) Single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl

2. Shade Cloth #2: Visually Opaque Single-Fabric Shadecloth with no Visible light transmittance.
   a. Mechoshade "Classic Blackout"
      1) Single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 75% vinyl (coating), 25% fiberglass (yarn)

2.3 WT03: MOTORIZED BLACK-OUT SHADE MANUFACTURERS

A. Manufacturers providing products in compliance with requirements include but are not limited to the following:

1. (Basis of Design): MechoShade Systems, Inc.; Electro series.
2. Nysan Shading Systems, Ltd.
3. Silent Gliss USA Inc.
4. Or equal.

B. Product: (Electro Model 4133)

1. Shade Cloth #1: Visually Opaque Single-Fabric Shadecloth with no Visible light transmittance.
   a. Mechoshade "Classic Blackout"

1) Single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 75% vinyl (coating), 25% fiberglass (yarn)

2.4 WT04: MOTORIZED SOLAR SHADE MANUFACTURERS (FLOOR MOUNTED)

A. Manufacturers providing products in compliance with requirements include but are not limited to the following:
   1. (Basis of Design): MechoShade Systems, Inc.; Electro series.
   2. Nysan Shading Systems, Ltd.
   3. Silent Gliss USA Inc.
   4. Or equal.

B. Product: (Model 4133)
   1. Shade Cloth: Visually Transparent Single-Fabric Shadecloth with light transmittance to be less than 3% (<3%).
      ~~b.~~a. Mechoshade "Thermoveil" or "Euroveil"
         1) Single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl.

~~2.4~~2.5 MOTORIZED ROLLER SHADES

A. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.

   1. Comply with NFPA 70.
   2. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
   3. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
      a. Service Factor: According to NEMA MG 1, unless otherwise indicated.
      b. Motor Characteristics: Single phase, 110 V, 60 Hz.
      c. Motor Mounting: Within manufacturer's standard roller enclosure.
   4. Position of Motor and Electrical Connection: Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
   5. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed. Provide the following devices for remote-control activation of shades:
      a. Control Stations: Momentary-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions.
         1) Color: As indicated in a window treatment schedule.

2) Product: Subject to compliance with requirements, provide "Decora Plus" by Leviton Manufacturing Co. Inc. As indicated in a window treatment schedule.

6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.
7. Operating Function: Stop and hold shade at any position.
8. Operating Features: Include the following:
   a. Group switching with integrated switch control; single face plate for multiple switch cut-outs.
   b. Capable of interface with audiovisual control system.
   c. Capable of accepting input from building automation control system.
   d. Override switch.
   e. Backup gear and crank operator for manual operation during power failures with detachable handle, 6 feet long.
9. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.
   a. Double-Roller Mounting Configuration: Side by side.
   b. Inside Roller:
      1) Drive-End Location: Right side of inside face of shade.
      2) Direction of Shade Roll: Regular, from back of roller.
   c. Outside Roller:
      1) Drive-End Location: Right side of inside face of shade.
      2) Direction of Shaded Roll: Regular, from back of roller.
10. Shade-to-Roller Attachment: Manufacturer's standard method.
11. Shade Retention System: Manufacturer's standard system for guiding shade through range of travel and holding shade taut with edges of shade supported by side channels.
12. Shades:
    a. Shade Material: Refer to Finish Schedule.
    b. Shade Bottom (Hem) Bar: Steel or extruded aluminum.
    c. Bottom bars Per manufacturer.
       1) Type: Enclosed in sealed pocket of shade material.
       2) Color and Finish: As selected by Architect from manufacturer's full range.

~~2.5~~2.6 FABRICATION

A. Prior to fabrication, verify actual opening dimensions by accurate site measurements. Provide one shade per window in room full length of window. Adjust shade sizes for proper fit at all windows.

B. Cut shade materials to suit window size, hemmed at bottom and top, of proper width to provide clearance for brackets indicated or required. Secure shade material to roller with metal window shade tacks or their equivalent. Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.

C. Finish fabric so that it will hang flat, without buckling or distortion. Edges, when trimmed, shall hang straight without unraveling. Seams shall be straight, uniform in both appearance and strength and shall be at least as strong as the fabric itself.

D. Furnish shade material in lengths not less than 12 in. longer than actual window dimension to permit shade to be operated full length without tearing from roller.

E. Provide manual shades in configurations mounted as shown with manual chain control and wall mounted chain holder. Provide solar shades in single pocket installation as shown.

F. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.

G. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

1. Do not penetrate window frames with fastenings of any kind.
2. Install shades so that shade fabric will hang flat, vertical and with edges aligned when rolled up.

B. Cooperate with other trades for securing window shades to finished surfaces.

C. Install metal parts isolated from concrete or mortar to prevent corrosion.

D. Install mounting brackets with not less than 2 fasteners per bracket.

E. Connections: Connect motorized operators to building electrical system.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer ensuring that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, with at least 7 days' advance notice.

END OF SECTION 122413

SECTION 123553 - METAL LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Mobile Casework System
   a. Painted metal mobile benches with wood fronts and tables.
2. Fixed Casework
   a. Painted metal, fixed benches with wood fronts.
   b. Painted metal wall cabinets with wood fronts.
3. Epoxy resin countertops and working surfaces.
4. Shelving and Support Systems
5. Mobile Tool Chest
6. Service Panels
7. Cabinets for solvents or flammable liquids (Special Application Cabinets).
8. Accessories.

B. Related Requirements:

1. Division 05 "Metal Fabrications" for miscellaneous metals.
2. Division 09 "Gypsum Board Assemblies" for reinforcements in metal-framed partitions for anchoring laboratory casework.
3. Division 11 “Fume Hoods” for fume hoods requiring base cabinets.
4. Division 11 "Laboratory Equipment" for equipment to be coordinated with laboratory casework.
5. Division 11 “Laboratory Service Fittings and Fixtures.”
6. Division 22 sections for:
   a. Specifications and installation of laboratory gases and associated piping.
   b. Installation of Service lines (including traps) and connection of such lines to laboratory casework, and all struts and hangers necessary to support such lines (except those service support struts integral with laboratory benches, service modules and service housings).
   c. Installation of lab waste, cold, hot water piping and other piped services, except at pre-piped casework.
7. Division 26 for the following electrical work related to laboratory casework:
   a. Furnishing of electrical and data raceways with receptacles, wiring and devices surface mounted on the walls.

b. Installation of electrical and data devices, wires and cover plates which are mounted on or casework or ceiling connections.

C. Work includes:

1. Furnishing all cabinets and casework, including tops, ledges, supporting structures, delivery to the building, setting in place, leveling and scribing to walls and floors. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.

2. Furnishing and delivering all utility service outlet accessory fittings, electrical receptacles and switches identified on drawings as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment packaged separately and properly marked for delivery to the appropriate contractor.

3. Furnishing and delivering for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.

4. Furnishing service strip supports where specified, and setting in place service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.

1.3 UNDIVIDED RESPONSIBILITY

A. Unless specified otherwise, because of special coordination requirements, the supplier of the scope of work described in this Section shall also provide the scope of work described in the following Sections:

1. Section 115313 - Fume Hoods.

2. Section 115343 - Laboratory Service Fittings and Fixtures.

1.4 REFERENCES AND QUALITY ASSURANCE

A. Work shall conform to the recommended practices of the Scientific Equipment and Furniture Association (SEFA), current version, except as superseded by this specification:

1. SEFA 2 - Installation.

2. SEFA 3 - Work Surfaces.

3. SEFA 7 - Fixtures.

4. SEFA 8-W -Laboratory Grade Wood Casework.

5. SEFA 8-M – Laboratory Grade Metal Casework.

B. Architectural Woodwork Standard (AWS), 2nd edition, published by the Architectural Woodwork Institute.

1. Wood, decorative laminate, and solid phenolic casework, and epoxy resin and solid phenolic resin worksurfaces shall comply with the AWS, second edition, for grades of casework, construction, finishes, and other requirements.

2. Provide AWI-QCP labels indicating that the casework and shelving, including installation, comply with the requirements of grades specified.
3. This project had been registered as AWI-QCP project number [insert number here].
4. The Contractor, upon award of work, shall register the work under this section with the AWI Quality Certification Program (QCP).

B. North American Architectural Woodwork Standards (NAAWS), current edition, published by the Architectural Woodwork Manufacturers Association of Canada (AWMAC), and Woodwork Institute (WI).

1. Wood, decorative laminate, and solid phenolic casework, and epoxy resin and solid phenolic resin worksurfaces shall comply with the NAAWS, current edition, for grades of casework, construction, finishes, and other requirements.

C. American National Standards Institute:

1. ANSI A208.1 – Particleboard, current edition.
2. ANSI A208.2 – Medium Density Fiberboard (MDF) for Interior Applications, current edition.
3. ANSI/HVPA HP-1 – American National Standard for Hardwood and Decorative Plywood, with the Hardwood Veneer Plywood Association, current edition.
4. ANSI/BHMA A156.9 Cabinet Hardware Standards, Grade 1.
5. ANSI/NEMA LD 3 High-Pressure Decorative Laminates.

D. State of California Air Resources Board (CARB): State of California Air Resources Board "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products," CCR Title 17, Sections 93120 – 93120.12.

1.5 PERFORMANCE REQUIREMENTS

A. Cabinets may be manufacturer's standard height and depth, provided such standard is not more or less than 1/2 inch of the height and depth indicated on the Drawings, unless noted otherwise in this Section.

B. System Structural Performance:

1. Laboratory casework and support framing system shall withstand the effects of the following loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:

   a. Casework, doors, drawers, work surfaces and shelving shall be in compliance with SEFA requirements for the respective casework material.

2. Work Surfaces: In addition to SEFA test requirements, work surface spans without continuous base cabinet support shall support 50 lb/sf; deflection shall be limited to 1/180 of the length of the span, not to exceed 1/4 inch.

3. Shelving: In addition to SEFA test requirements:

   a. Shelf spans without continuous support shall support 50 lb/sf.
      1) Deflection shall be limited to 1/144 of the length of the span, not to exceed 1/4 inches.

4. Suspended shelving systems:
   a. Design to support framing and live load requirement identified for casework above.

1.6 DESIGN REQUIREMENTS

A. Flush overlay construction: Surfaces of doors and drawers shall overlay the cabinet ends, top or bottom rails. Horizontal and vertical case shell members (panels, top rails and bottoms) shall be concealed behind drawer and door fronts.

1. Steel Fronts: Reveals shall be a uniform 1/8" horizontally between drawer and door fronts and 5/16" vertically between adjacent drawer and door fronts.

2. Wood Fronts:
   a. Door and drawer fronts within a single cabinet front shall be vertically matched.
   b. Due care shall be given to the selection and arrangement of wood materials so that the finished installation will provide an attractive and harmonious appearance. Fronts should be selected and arranged within an elevation so that color and graining of adjacent veneers is balanced to be in conformance with the standard of care expected of higher education research installations within the scientific laboratory equipment industry.
   c. Reveals shall be a uniform 1/8", vertically and horizontally, between adjacent drawer and door's fronts.

B. Slimline styling: Front width of end panels 3/4" and front height of top and bottom members 1".

C. Self-supporting design: Units shall consist of a completely welded shell assembly without applied panels at ends, backs or bottoms. Cases shall be designed to be installed in series or interchangeably as single, stand alone units. Each cabinet shall be fabricated and finished as a complete unit, so that units can be relocated at any subsequent time without requiring field application of finished ends or other parts.

D. Case units:

1. All cabinets shall have an easily cleanable and accessible, smooth interior. Bottom edges shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges, and front edge shall be offset to create a seamless drawer or door recess rabbet for dust stop.

2. Rabbeted style opening design all four sides of case opening for hinged doors, and on two or four sides for sliding doors, shall provide structural integrity and resist dust.

3. Base cabinets up to 48” wide with double swinging doors, shall be designed without center vertical post.

E. Drawers: Sized on a modular basis for interchange to meet varying storage needs, and designed to be easily removable in field without the use of special tools.

F. Framed glazed doors: Identical in construction, hardware and installation to solid panel doors. Design frame glazed doors to be removable for glass replacement.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Purpose of the meeting will be to review submittal requirements, physical and building service requirements, rigging and other requirements for installation in the facility, installation of work to

be provided by others, where applicable, and other issues related to laboratory casework design, manufacture and installation.

1.8 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for each type of laboratory casework unit required.

1. Include independent laboratory certification that applied finishes comply with specified chemical and physical resistance requirements, and casework manufacturer's certification that work of this Section complies with other specified requirements.

B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, and attachment details.

1. Indicate types and sizes of fixed and mobile metal casework and tables.
   a. Submit full scale joinery and all fully dimensioned typical details showing sizes, materials, substrates and finish for all metal casework components, support strut sizes and locations. Include material quality certifications for metal and epoxy resin countertops. All details to be keyed to a furniture schedule showing plans, elevations and sections of each cabinet type at 3/4"=1'-0" and referencing architect's numbers for cabinet types.
   b. All manufactured components: including but not limited to shelf and shelf support details and finishes, name and fixture cuts of the single-source laboratory fixture suppliers, schedule of cabinet hardware. Submit all required literature, catalog cuts and performance tests.
   c. Detailed lab furniture and lab item schedule cross referencing manufacturer's proposed nomenclature to be used throughout all shop drawings to architect's for all lab items.
   d. Work surfaces: Show location of field joints and all typical details for all types of surfaces including but not limited to: edge and drip details, connections, typical joints, cut-outs for sinks, cup sinks and fixtures.

2. Indicate locations of hardware and keying of locks.

3. Indicate locations and types of service fittings.

4. Indicate locations of blocking and reinforcements required for installing laboratory casework.

5. Include details of utility spaces showing supports for conduits and piping.

6. Include details of support framing system.

7. Include details of exposed conduits, if required, for service fittings.

8. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.

9. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples for Verification: For each type of cabinet finish and each type of countertop material, in manufacturer's standard sizes.

D. Samples for Verification: Unless otherwise directed, approved full-size Samples may become part of the completed Work, if in an undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations. If acceptable full-size Samples at Project site are not incorporated into the Work, retain and remove them when directed by Architect.

1. One full-size, finished base cabinet complete with hardware, doors, and drawers.

2. One full-size, finished wall cabinet complete with hardware, doors, and adjustable shelves.

3. One Sample each of hinged and sliding doors.

4. 6-inch- square Samples for each type of countertop material.

5. One of each service fitting specified, complete with accessories and specified finish.

6. One of each type of hardware item specified.

E. Qualification Data: For manufacturer.

F. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard.

G. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

H. Furnish complete touchup kit for each type and color of metal laboratory casework provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

I. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 QUALITY ASSURANCE

A. Single Source Responsibility: Provide laboratory casework with tops, sinks, and service fixtures, manufactured or furnished by a single laboratory casework company for single responsibility.

C. Manufacturer Qualifications:

1. Work in this section shall be performed by a company having a minimum of eight years documented experience manufacturing the respective products specified herein, and an established organization and production facilities including all tools, equipment and special machinery necessary for the fabrication and installation of the type of equipment required, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.
2. Casework manufacturer must have at least one project in the past 12 months where the value of the laboratory casework was within 20 percent of the cost of the laboratory casework for this project.

D. Installer Qualifications:

1. Casework installers shall be approved in writing by the casework manufacturer for the installation of specified products.

B. Chemical and Physical Resistance of Finish:

1. General: Submit an independent testing laboratory report certifying that the exterior finish of laboratory casework is capable of withstanding following tests with no change, or slight change of gloss, slight discoloration, or slight temporary softening of film with no loss of adhesion and no loss of film protection.

2. Acids: Not less than 5 drops (0.25 cc) applied to finish surface, covered with watch glass for 60 minutes, then washed and dried.

C. Mockups:

1. Refer to Division 01 “Mockups” for additional requirements.

2. Provide full size casework installation, complete with cabinets, shelving, hardware, laboratory fittings and fixtures, electrical devices, fume hoods, etc. as indicated in the drawings. Mock up shall include at least one drawer. Include base as indicated in Finish Schedule.
3. Approved mock-up may remain part of work.

4. Approved mock-up may be relocated to the project and reinstalled. Scratches, blemishes, dents, holes, etc. resulting from disassembly and reassembly shall not be acceptable.

1.10 DELIVERY, STORAGE, AND HANDLING

E. Contractor shall schedule the delivery of casework and furnishings when spaces are sufficiently complete so materials can be installed immediately following delivery.

F. Protection: Use all means necessary to protect work of this section before, during and after installation including installed work and materials of other trades.

1.11 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

1.12 PROJECT SITE CONDITIONS

A. Field Measurements: Where laboratory casework components are indicated to fit within or relative to walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Environmental Limitations: Do not deliver or install laboratory casework until utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.13 WARRANTY

A. Special Project Warranty: Submit written warranty signed by laboratory casework manufacturer, and countersigned by Contractor, agreeing to replace laboratory casework and materials provided as work of this section that develop defects in materials and workmanship within one year of date of Substantial Completion, will be repaired or replaced to the satisfaction of the Owner and the Architect, at no addition to the Contract Sum.

PART 2 - PRODUCTS

2.1 CASEWORK MANUFACTURERS

A. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

A. Manufacturers providing products in compliance with requirements include the following:

1. (Basis of Design) Kewaunee Scientific; Statesville, North Carolina.
2. Bedcolab; Laval Quebec, Canada.
3. Lab Crafters; Ronkonkoma, NY.
4. Mott Manufacturing; Brantford, Canada

2.2 MOBILE METAL LABORATORY CASEWORK

A. Provide mobile painted metal laboratory casework system with self-supporting workstations, single and double sided with adjustable height work surfaces, integrated shelving systems, pre-plumbed integrated services and pre-wired integrated power and data and mobile tables. Electrical and plumbing utilities are concealed in ceiling. Flexible, modular casework connects via flexible hoses and quick-disconnects at ceiling mounted fixtures and receptacles.

B. Manufacturer and Product:

1. (Basis of Design): "Enterprise Free Standing Laboratory Workstation System" as manufactured by Kewaunee.
   a. Acceptable manufacturers and Products:
      1) Bedcolab; Symphony II Table System.
      2) Lab Crafters; Mobile Casework.
      3) Mott Manufacturing; Brantford, Canada

2. Casework: (Basis of Design) Kewaunee "Enterprise Style 1": full overlay construction, with doors and drawer fronts overlapping the cabinet face frame.
   a. Doors and drawer fronts: 3/4" thick, square edged and attached pull.

b. Swinging doors: 5 knuckle stainless steel hinge with a positive door latching mechanism to prevent rebounding. Drawer shall have a one piece body and 150 lb. self closing drawer guide.

C. Construction:

1. Freestanding workstation system shall be comprised of work surface support frames adjustable from 30-inches to 37-inches AFF, and a rear frame support structure, single or double sided, incorporating a vertical post and horizontal support. Vertical supports shall incorporate individual slots for adjustable shelving and accessories. Vertical support shall accept a separate removable chase for plumbing and wiring of services.

2. Freestanding work Station System:
   a. Worksurface Support Frame:
      1) Frame shall be a welded four sided assembly consisting of 11 gauge steel channel formations, front adjustable height legs, and rear attachment collars. Nominal lengths are 42”, 48”, 54”, 60”, 66”, 72” and 96”.
      2) Adjustable height shall be 30” to 37” AFF including 1” work surface.
      3) Front leg members shall be 11 gauge steel tubes, 2” outside diameter and 1.75” inner telescoping leg capable of vertical adjustment in 1” increments.
      4) Legs shall include non-marring, 3/8” diameter, levelers.
      5) Rear corners shall have 2.25” diameter x 6” high, 11 gauge half-round collars welded to the worksurface frame with supporting gussets and shall be mechanically fastened to the rear upright supports with Button Head Socket Cap Screws.
      6) Load rating shall be 100 lbs per linear foot of length to a maximum of 800lbs. With uniformly distributed load, the maximum allowable deflection shall be .125” measured at the center of the front rail.
      7) A full length horizontal rear cabinet stop shall be located under the work surface frame to position 24” deep mobile base cabinets 1” behind the front edge of the work surface.
   b. Double-sided Rear Frame Support Structure:
      1) The rear frame support structure shall be 84” in height and available in nominal lengths of 42”, 48”, 54”, 60”, 66”, 72”, and 96”.
      2) Rear frame support structures shall consist of four (4) 2” diameter full height vertical members, connected with a horizontal framing assembly that incorporates upper and lower horizontal cross rails. The upper cross rail shall provide a utility trough the full length of the table. The lower cross rail shall support integral double sided electrical and central plumbing raceway. The raceway may be specified with plumbing, electrical & data as required. Plumbing lines and wiring shall feed through a 6” vertical member centered between the full height vertical members. The 6” vertical member and the lower horizontal member shall have easily removable access panels, with no exposed fasteners. For 42” and 48” tables, the center vertical member can be eliminated if plumbing fittings are not required in the horizontal lower member, allowing for full length shelves.
      3) In addition to the horizontal framing structure, the 2” vertical members shall be able to accommodate and a duplex electrical receptacle located below the worksurface.
      4) Each vertical member shall include non-marring 3/8” diameter, levelers.
      5) The vertical members shall have shelf/accessory slots punched on 1” increments starting at 55” above AFF to top of upright.
      6) Double sided rear frame support structures shall accept an extruded aluminum removable chase that fits flush between the two 2’ vertical members on either side of the frame. This chase shall extend from top of rear

frame to 30” AFF to allow for service piping and fitting to be mounted vertically on this chase at either end of the bench.

c. Single-sided Rear Frame Support Structure:
   1) The rear frame support structure shall be 84” in height and available in nominal lengths of 42”, 48”, 54”, 60”, 66”, 72”, and 96”.
   2) Rear frame support structures shall consist of two (2) 2” diameter tube vertical members, with horizontal framing members. The vertical members shall allow the installation of service fittings.
   3) The vertical members shall be able to accommodate up to three services each and a duplex electrical receptacle or data outlet.
   4) Vertical members shall include non-marring, 3/8” diameter, levelers.
   5) All rear frame support structures in widths of 60” wide and over shall have a center support to accommodate split shelving.
   6) The vertical members shall have shelf/accessory slots punched on 1” increments on the front starting at 55” above AFF to top of upright.
   7) Rear frame support structures shall incorporate upper and intermediate horizontal cross rails. The intermediate cross rail shall support an integral two channel raceway with removable

d. Plumbing Service Tubes: Factory installed, designed to convey services from inlet at top of leg to outlet of factory-installed service fixture connection in the leg wall below. Construct tube of material as follows:
   1) Air and Vacuum Service: Copper or polyurethane.
   2) Natural Gas Service: Stainless Steel.

e. Electrical Services: Factory installed and prewired.
   1) 120 Volt Electrical Power: 20 Amp duplex outlet, black. 3 wire. Cover plate at leg mounted outlet to be stainless steel or color matched urethane powder coated steel. Provide GFI type outlets at sink benches and where indicated on Drawings.
   2) Telecommunications: Two outlet, RJ-45 type. Category 5e or 6 cabling; coordinate with wiring installer to provide appropriate cabling and terminations.

f. Accessories: Provide accessories where indicated on Drawings:
   1) Backsplash Panels: Epoxy panel with stainless steel bottom channel for attachment to work surface frame. ½” min., per manufacturer’s standard.
   2) Plexiglass Splash Guards: Custom item, installed on top of backsplash panel where indicated; thickness to match panel. Secure guards to phenolic panel below using silicone adhesive and plexiglas dowels set into curb. Secure guards at top to horizontal cross rail using stainless steel bolts and with stainless steel clips as specified by manufacturer.
   3) Modesty Panels: Powder coated steel panels, designed to mount to tubular rear frame assembly below counter top, using hardware enabling future removal and re-use by Owner.
      a) Height: 19” nominal.
   4) Privacy Panels: Powder coated steel frame and rear panel, designed to mount above counter top, using hardware enabling future removal and re-use by Owner.
      a) Height: 16” nominal.
      b) Front surface: Porcelain coated steel, magnetic marker board surface, set within the powder coated steel frame.
      c) Include one boxed set of 1 2 (min.) metallic magnets and cleaning solution with each panel.

2.3 MOBILE TABLES

A. Four Leg Adjustable Table:

1. The four leg table shall consist of a worksurface support frame. Nominal lengths are 42”, 48”, 54”, 60”, 66”, 72” and 96”. Two additional leg members shall be bolted to the rear attachment collars to provide a four leg self-supporting table frame, adjustable in height from 30” to 37” AFF including 1” work surface.

2. Construction: As specified above for Mobile Benches. Front and rear leg members shall be 11 gauge steel tubes, 2” outside diameter and 1.75” inner telescoping leg capable of vertical adjustment in 1” increments

3. Legs shall include non-marring, 3/8” diameter, levelers.

4. Load rating shall be 100 lbs per linear foot of length to a maximum of 800 lbs. With uniformly distributed load, the maximum allowable deflection shall be .125” measured at the front center rail.

2.4 FIXED METAL LABORATORY CASEWORK (CFCI)

A. Provide fixed casework with flush overlay construction and concealed horizontal and vertical case shell members utilizing a self-supporting design consisting of completely welded shell assembly without applied panels at ends, backs or bottoms. Cases shall be designed to be installed in series or interchangeably as single, stand alone units. Each cabinet shall be fabricated and finished as a complete unit, so that units can be relocated at any subsequent time without requiring field application of finished ends or other parts.

B. Manufacturer and Products:

1. (Basis of Design): "Research Collection Laboratory Furniture" as manufactured by Kewaunee.
   a. Acceptable manufacturers and Products:
      1) Bedcolab; Harmony Flush Overlay.
      2) Lab Crafters; Fixed Casework.
      3) Mott Manufacturing; Brantford, Canada

C. Materials:
   a. Sheet steel: Mild, cold rolled prime grade U.S. Standard; roller leveled, and free of scale, ragged edges, deep scratches or other defects. Gauge of steel used in construction shall be 18 gauge except as noted below:
      1) Minimum gauges:
         a) 20 gauge: Exterior/interior drawer fronts, interior door panels, scribing strips, filler panels, enclosures, drawer bodies, shelves, security panels and sloping tops.
         b) 18 gauge: Door fronts, case tops, ends, bottoms, bases, backs, vertical posts, uprights, and access panels.
         c) 16 gauge: Top front rails, top rear gussets, intermediate horizontal rails, table legs and frames, leg rails and stretchers.
         d) 14 gauge: Drawer suspensions, door and case hinge reinforcements and front corner reinforcements.
         e) 12 gauge: Table leg corner brackets and gussets for leveling screws.

2) Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
3) Finish: Color to be selected by the Architect.

b. Glass for framed, glazed swinging and sliding doors: 6mm Safety Glass, tempered or laminated.

c. Wood: For door and drawer fronts and facing panels.
1) Core: 3-ply, non-urea formaldehyde, fiberboard or particleboard with high recycled content. Submit recycled content information as specified in “Submittals” article above.
2) Veneer: Shall be Grade A plain sliced White Maple, vertical matched, slip matched and running matched.
3) Banding: Edge banding matching panel veneer.

D. Fabrication:

1. Base Units, Wall, Upper and Tall Cases:
a. Base units and nominal 20", 30" and 36" high wall cases: End panels and back reinforced with internal reinforcing front and rear posts. Base units shall be 22" overall in depth except where indicated otherwise on Drawings.
b. 25”, 31”, 49" and 84" high tall cases: Formed end panels with front and rear reinforcing post channels; back shall be formed steel panel, recessed 3/4" for mounting purposes.
c. Posts: Front post shall be fully closed with full height reinforcing upright. Shelf adjustment holes in front and rear posts shall be perfectly aligned for level setting, incrementally adjustable to not more than 1" o.c. over the full height of unit.
d. Secure intersection of case members with spot and arc welds.
e. Provide gusset reinforcement at front corners.
f. Base unit backs: Provide drawer units without backs and cupboard units with removable backs for access to services behind units.
g. Bottoms: Base units and nominal 24", 30", 36" and 48" high wall and upper cases shall have one piece bottom with front edge formed into front rail, rabbeted as required for swinging doors and drawers and flush design for sliding doors.
h. Top rail for base units: Interlock with end panels, flush with front of unit.
i. Horizontal intermediate rails: Recessed behind doors and drawer fronts. Provide between doors and drawers, and between drawers where required by locks in drawers.
j. Base for base units: 4" min. high x 3" deep with formed steel base and minimum12 gauge die formed steel gussets at corners. Provide 3/8" diameter leveling screw with integral bottom flange of minimum 0.56 sq. in. area at each corner, accessible through plugged openings in the bottom pan or openings in toe space. Each leveling bolt and gusset shall be capable of supporting 500 lbs; leveling bolts requiring special tools to adjust are not acceptable.
1) Where toe space base is omitted for units to set on building bases or other separate steel bases, then the toe space rail shall extend back 4-1/2".

2. Tops of wall and upper cases: One piece, with front edge formed into front rail.

2.5 ADJUSTABLE SHELVING

A. Adjustable Shelves at mobile benches shall be supported by 11 gauge brackets which mount to the slots in the rear frame support structure. They shall be adjustable in height on 1" increments.

B. Wall Standards for wall mounted shelving shall utilize a 2” diameter tube to match the vertical members of the single-sided rear frame support structure. The slot pattern shall allow for 1” height adjustment.

1. Shelves shall be available in depths of 9", 12", and 15” and nominal lengths of 21”, 24”, 30”, 36”, 42” and 48” to match the slots on the rear frame support structure.

2. Shelf Materials
   a. Mobile Bench Shelves: Steel shelves shall be 16 gauge steel, formed down 1" then returned back and up into a channel formation. They shall attach to the shell brackets without additional hardware or adhesive and shall be installable without tools. Steel shelves shall have a steel retaining lip on the front and/or rear. Shelves shall have a front retaining rod of 3/8” diameter stainless steel with a satin clear finish, and a matching 1” steel retaining lip on the rear. Shelves shall overhang 2” or greater (per manufacturer’s standard) behind the face of the vertical tubular support.
   b. Wall Shelves: Steel shelves are to be minimum 16 gauge cold rolled steel, formed to a 1” thick profile mounting to support structure with a powder coated, 11 gauge cold rolled steel frame. Shelves shall have a front retaining rod of 3/8” diameter stainless steel with a satin clear finish. Provide wall shelves of wood construction as specified above, but without rear retainer, only where indicated on Drawings.
   c. All shelves shall be of interchangeable design to mount in either wall standards or bench rear frames. Shelf retainer lip at lower and middle shelves shall be “reversible” so it can be repositioned to a raised or flush position with the use of simple hand tools. Shelf retainer lip at upper shelves shall be removable with simple hand tools.

2.6 MOBILE TOOL CHEST

A. Provide mobile painted metal toolchest casework systems where indicated on drawings Manufacturer and Product:

1. (Basis of Design): Vidmar SCU1704AL as manufactured by Stanley Vidmar; Allentown, PA .
   a. Acceptable manufacturers and Products:
      1) Lista: Los Alamitos, CA
      2) Uline; Pleasant Prairie, WI

B. See spec 123619 for Wood Countertop requirements. Minimum thickness shall be 1 ¾”.

C. Mobile Tool Chest Basis of design
   1. Drawers Shall comply with Vidmar drawer types 20, 45 and 70
   2. Finish and color to be selected by architect from manufacturers standard color line.
   3. Desk / Workstation Height with 2” casters. Maximum height of unit shall be 32”, must be able to slide under casework mobile tables and benches.

2.7 SERVICE PANELS

A. Mobile Bench Overhead Service Panels: Powder coated steel ceiling service panel engineered and furnished by the manufacturer in a color to be selected by Architect. Panel shall be furnished complete with outlets, quick-connect fittings, flexible piping and cabling, and all other components required to bring indicated services to the Mobile Benches.

1. General requirements: Utility panels shall provide a means to mount and connect electrical outlets, data outlets and quick connect service fixtures serving below-ceiling components of the laboratory furniture system such as single and double sided movable benches, service carriers etc. Utility panels shall be designed by the manufacturer to integrate within a standard, 15/16” wide ceiling suspension system grid.

2. Construction: Minimum 18 gauge cold rolled steel with a urethane powder coat finish.

3. Nominal Dimensions:
   a. Height (including electrical junction boxes): 3"
   b. Widths: As shown on Drawings.

4. Electrical power devices: 3-prong, NEMA L5-20R, 20 AMP 125V 2-pole, 3-wire, twist lock, flush receptacles. Color: Black.

5. Cover plates: Plates for standby (emergency) power shall be red thermoplastic nylon. Plates for normal power service shall be stainless steel.

6. Cover plates for telecommunications devices: Stainless steel. Coordinate face plate style with telecommunications installer.

7. Plumbing Service Fixtures: Ceiling Utility Panel system shall include locking, color-coded keyed quick-connect fittings for each service indicated. Each quick-connect shall include nipple and coupler with color-keyed band marking media. Refer to Division 12 section “Lab Sinks Fixtures and Accessories” for fixture specification.

8. Blank Plates: Provide stainless steel cover plates at all electrical cut-outs where services are not required. Provide knock-outs of same finish as panel where plumbing services are not required.

9. Coordinate pre-piping and wiring as required with Construction Manager. Shop Drawings shall clearly show all services to be provided at each Panel location.

10. Installation of Services:
    a. Junction boxes for electrical and telecommunications services: All junction boxes shall be factory attached.
    b. All electrical outlets and service fixtures shall be provided by the laboratory casework manufacturer and be factory installed. Cover plates shall be factory or field installed as approved by the Construction Manager.
    c. Telecommunications outlets and all electrical and low voltage wiring shall be provided and installed by others. Coordinate installation with Construction Manager.

11. Exposed piping and cabling from ceiling panels to benches shall be concealed by a removable flexible plastic shroud of style and finish to be selected, or dressed by black UV stabilized cable ties. Selection to be made by Owner and Architect based upon mockup installation.

2.8 SPECIAL APPLICATION CABINETS

A. Undercounter Ventilated Cabinets

1. Construction: Construct as specified for metal laboratory casework in a matching door style. Interior shall be fully lined with polypropylene plastic.

2. Ventilation: Provide a 2-inch polypropylene vent pipe at the outside rear of the cabinet with 2 inlets, 1 high and 1 low. Secure vent pipe inlets to back of cabinet with polypropylene locking nuts. Extend vent pipe into fume hood interior and connect to raised outlet in work surface as specified in Division 11.

3. Doors: Provide with polypropylene or ABS roller catches with plastic screws.

4. Bottom: Provide with one-piece, 1/4-inch thick heat welded, polyethylene plastic pan, liquid tight, removable, 1 inch deep.

5. Shelving: Provide with a half depth, adjustable shelf for the full width of the cabinet with polypropylene shelf clips.

6. Identification: All ventilated storage cabinets shall be marked with conspicuous lettering: CAUTION - CORROSIVES

7. Finish: As specified for metal laboratory casework. Color to be selected by the Architect.

B. Flammable Storage Cabinets

1. Description: Design and construct in accordance with OSHA Regulations and the requirements of NFPA 30, National Fire Protection Association, Flammable and Combustible Liquids Code. Cabinets shall limit the internal temperature at the center 1 inch from the top to not more than 325 degrees Fahrenheit when subjected to the fire test for storage cabinets as described in NFPA 30.

2. Cabinets shall be third party tested and Factory Mutual (FM) approved and/or Underwriters Laboratories (UL) listed accordingly.

3. Casing: Bottom, top, back, door, and sides of cabinet shall be at least 18-gage sheet steel, double walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.

4. Doors: Doors shall be self-closing and self-latching. Provide with continuous piano hinges, 3 point latch arrangement, and fusible link type hold-open device which melts at 165° F. Door sill shall be raised at least 2 inches above the bottom of the cabinet to retain spilled liquid within the cabinet.

5. Ventilation: Cabinet shall not be ventilated unless required by local authorities. Vent openings shall have integral flame arrestors; non-ventilated cabinets shall be sealed with plugs, inside and outside, supplied by the manufacturer.

6. Shelving: Provide with a full width adjustable shelf.

7. Grounding: Cabinets shall be manufactured with an electrical grounding lug for connection to the building ground system by Division 16.

8. Identification: All flammable storage cabinets shall be marked with conspicuous lettering: FLAMMABLE - KEEP FIRE AWAY.

9. Finish: As specified for metal laboratory casework. Color to be selected by the Architect.

C. Vacuum Pump Cabinets

1. Construction: Design and construction as specified for metal laboratory casework. Cabinets shall be specifically designed for vacuum pump storage to provide a means to store and vent vacuum pumps and their emissions and heat loads.

2. Vacuum pump cabinet shall incorporate acoustical insulation on the interior door panels, sides, back and underside of the top panel. Insulation shall be an open cell foam of acoustical pattern design.

3. Cabinet shall have hinged, louvered doors with integral toe space without a cabinet bottom. Back panel(s) shall be removable for utility access and visual inspection. Back panel shall incorporate an integral 2-½-inch vent hole for a separate vent assembly. Base cabinets, 30" and wider, with double swinging doors shall provide full access to complete interior without center vertical post.

4. Separate mobile vacuum pump platform shall be capable of supporting 300 lbs. Front two casters shall be locking/swivel models. Lipped construction shall safely contain any accidental spills.

5. Furnish unit with 4-inch diameter duct collar for connection to the building HVAC exhaust system.

6. Electrical:
   a. Unit shall incorporate an integral electrical switch (120V, 20 amp) with pilot light to indicate the operational mode of the vacuum pump unit.
   b. Storage unit shall have an electrical duplex outlet, located in the rear of the cabinet, for the vacuum pump plug end. Outlet to be accessible from the inside of the cabinet. Outlet shall be hard wired to the electrical switch.

2.9 HARDWARE

A. Drawer and hinged door pulls:

1. Style: ADA compliant, stainless steel bow wire pulls from one of the following: Hafele America model 115.60.602, Mockett model DP33B, Schaub & Company SSBow 128

2. Drawer and door pulls shall be mounted on 4-3/4 inches to 5 inch centers, offering a comfortable hand grip, and be securely fastened to doors and drawers.

3. They shall be manufactured from 3/8” diameter stainless steel rod arched bow design with a brushed satin finish.

4. Pull Orientation: Horizontal on drawers, vertical on doors.

5. Provide two pulls at drawers over 30 inches wide.

6. Provide tab style pull of matching style for tablet arms.

B. Sliding door pulls: Recessed stainless steel, styled and sized to harmonize with drawer pulls.

C. Hinges: Institutional type, five knuckle projecting barrel hinges, minimum 2 1/2" long, type 302 or 304 stainless steel with a minimum 150 pound load rating, color to match casework selection. Drill each leaf for three screw attachment to door and frame. Provide two hinges for doors up to 36" high; three hinges for doors over 36" high.

D. Door catches: Adjustable type, two-piece heavy-duty cam action positive catch type or heavy duty adjustable spring actuated nylon roller catch.

E. Elbow catches: Spring type of cadmium plated steel, with strike of suitable design.

F. Shelf clips: Die formed steel, zinc plated, designed to engage in shelf adjustment holes.

G. File followers: Metal backs engaging in steel bottom channel, with spring positioning lock.

1. Provide in all file drawers.

H. Locks:

1. Type: National Lock Remove A Core 5 disc tumbler, heavy duty cylinder type. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers.

2. Keying: “Master Key” system. Locks shall have capacity for 225 primary key changes. Master key one level with the potential of 40 different, non interchangeable master key groups.

3. Keys: Stamped brass available from manufacturer or local locksmith, and supplied in the following quantities unless otherwise specified:
   a. 2 for each keyed different lock.
   b. 3 for each group keyed alike locks.
   c. 2 for master keys for each system.

4. Where required: Provide locks at all tall cases, wall cases, file drawers and where indicated on Drawings.

I. Label holders: Formed steel with satin chrome finish, 1" x 1 1/2", screw installed.

1. Provide label holders at all tall cases and mobile cabinets, and where indicated on Drawings.

2.10 ACCESSORIES

A. Kneespace Panels: Provide at all knee openings at wall and island benches. Horizontally split panels above base molding to allow for removal of main panel for access to utility chase without disturbing applied base.

1. Knee space panels at island benches shall be integral to the laboratory furniture support system.

2. Provide factory cut-outs at all knee space panels for electrical outlets. Center cut-outs in panels at a height of 18-inches above finished floor.

3. Provide stainless steel blank cover plates at all cut-out locations where electrical devices are not provided by Division 26.

4. Do not provide kneespace panels at locations where under-counter equipment is indicated.

B. Aprons: Box type aprons must be used to support work surfaces at knee spaces and other openings 18-inches and wider. Rail type aprons are acceptable at smaller openings.

1. Apron depth at knee spaces: 4-inches, consistent across opening. Aprons with “kicker” ends are not acceptable.

2. Aprons at ADA designated knee spaces: Use manufacturer’s standard ADAAG compliant design.

3. Aprons at under-counter equipment spaces: Use manufacturer’s standard low profile design.

4. Apron Reinforcement: Provide steel channel reinforcing at work surfaces with aprons spanning 42-inches or greater. Edge of work surface should be capable of supporting a 200 lb. point load.

C. Leg Shoes: Extruded vinyl or rubber, black, open bottom type. Provide on legs at island casework or where legs are part of built-in casework. Do not provide on table legs where legs have glide bottoms.

D. Base molding: 4-inches high, to be furnished and installed on all fixed base cabinets and cases by Division 9 flooring contractor.

E. Corner base guards: 4-inches high, Type 304 stainless steel corner guards. Install at all outside corners of fixed benches following installation of base molding.

F. Sink Supports: Sink supports shall be hanger type, suspended from top front and top rear horizontal rails of sink cabinet by four 1/4" dia. Galvanized steel rods, threaded at bottom end and offset at top to hang from two full length reinforcements welded to the front and rear top rails. Two 3/4" x 1-2/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle.

1. When sink capacity exceeds 3,750 cu. in., the sink supports shall be suspended from full-length reinforcements welded to the two end rails. Two 1" x 2" x 10 gauge full-length channels shall be hung from the four 1/4" dia. rods to provide a heavy duty sink cradle.

2.11 EPOXY COUNTERTOPS AND WORK SURFACES

A. Epoxy Countertops: Manufacturers providing products in compliance with requirements include the following:

1. ChemTops
2. (Basis of Design) Durcon, Inc.: Green Stone
3. Kemresin

B. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled.

1. Color: To be Selected by Design Professional from manufacturer's full color range.

C. Top Sizes: Supply tops in maximum practicable lengths, or as indicated in the drawings, but never less than 30" unless otherwise noted on plans. Locate field joints, and design detail of joint, only as indicated on final shop drawings.

D. Top Thickness: For each type of top and application, maintain 3/4-inch minimum thickness indicated, with tolerance not exceeding plus or minus 1/32-inch. Provide continuous drip groove on under surface 1/2-inch from edge. Provide marine edge at sink locations.

E. Epoxy Countertops and Tabletops:

1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

   a. Countertop Configuration: As indicated.
   b. Countertop Construction: Uniform throughout full thickness.
   c. Backsplash: Applied back and side splash, same mat and thickness as countertop, 4-inches high where countertop abuts walls, size and configuration as indicated.

2. Fabrication: as standard with manufacturer.
3. Physical Properties:

   a. Flexural Strength: Not less than 10,000 psi.
   b. Modulus of Elasticity: Not less than 2,000,000 psi.
   c. Hardness (Rockwell M): Not less than 100.
   d. Water Absorption (24 Hours): Not more than 0.02 percent.
   e. Heat Distortion Point: Not less than 260 deg F.

4. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

   a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
   b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

2.12 STAINLESS STEEL TOPS

A. Stainless Steel Tops (Top Material Type "S"):

1. General: Provide 14-gage stainless steel sheet, AISI Type 316L throughout, with No. 4 satin finish. Weld shop joints, grind smooth and polish to become practically invisible at all welded connection. Provide hair-line butt jointed field joints, mechanically bolted through continuous channels welded to underside at edges. Keep field jointing to a minimum. Apply reinforcing channels to underside of top where necessary to insure rigidity without deflection.
   a. Extend top down to provide a 1-inch thickness and 1/2-inch return flange under frame. Sound-deaden entire under-surface with heavy build mastic coating.
   b. Form backsplash to be coved to and integral with top surface.

c. Provide a raised marine edge around perimeter of all tops. Provide level top except, where pitch is indicated, Pitch top surface two-ways to bowl to provide adequate drainage without channeling or grooving.

d. Where stainless steel sinks occur in stainless steel tops, factory assemble sinks and tops into one integral unit with welds ground and polished.

2.13 FABRICATION METAL CASEWORK AND TABLES

A. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt- and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.

B. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.

C. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

D. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.

E. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

F. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges unless otherwise indicated.

2.14 LABORATORY ACCESSORIES

A. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent sink unless otherwise indicated. Final color to be selected by Architect.

B. Pegboards: Polypropylene, epoxy, or clear acrylic pegboards with removable clear polypropylene pegs and stainless-steel drip troughs with drain outlet.

2.15 SERVICE FITTINGS

A. Refer to Division 11 "Laboratory Service Fittings and Fixtures" and Division 22 sections for sinks and service fittings to be coordinated with Laboratory Casework.

B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.

2.16 ELECTRICAL AND COMMUNICATION SERVICE FITTINGS

A. Service Fittings, General: refer to Division 26.

2.17 METAL CABINET FINISH

A. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.

B. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 M. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

2. Colors for Metal Laboratory Casework Finish: as selected by Design Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation of the work of this Section, carefully inspect the installed work specified in other Sections and verify that all such work is complete to the point where this installation may properly commence.

B. Verify that all work may be installed in complete accordance with the original design, reviewed submittals, and the manufacturer's recommendations.

C. Verify adequacy and proper location of any required backing or support framing.

D. Verify that mechanical, electrical, plumbing and other building components affecting work in this Section are in place and ready.

3.2 PREPARATION

A. Project Conditions: Casework and furnishings shall not be delivered and installed prior to completion of the followings items:

1. Windows and doors shall be installed and the building shall be weather-tight.
2. Finished ceilings, if specified, overhead ductwork, piping, electrical, and lighting work shall be installed.
3. Painting shall be complete.

4. Flooring shall be installed, except when an integral base as specified to be installed over the casework toe kick.
5. Interior building temperature shall be maintained between 65 degrees F and 80 degrees F, and ambient relative humidity shall be maintained between 25 percent and 55 percent prior to delivery, and during and after installation. Frequent and/or excessive changes in temperature and/or humidity levels during casework installation, or once casework is installed, must be avoided to prevent damage to materials.

B. Delivery:

6. Product shall be stored in a clean storage area.
7. Delivery of laboratory casework shall be made only when the area of operation is enclosed, all plaster and concrete work is dry, and the area broom clean.

C. Discrepancy: In the event of discrepancy, immediately notify the Architect.

3.3 INSTALLATION

A. Installation of items specified in this Section shall be performed by installers experienced in the installation of the respective item as determined by the respective manufacturer.

B. Coordinate work with any Owner furnished and/or installed components indicated on drawings.

C. Any fixed cabinet, casework system panel, or system structural component shall require the use of a tool for removal. Any component designed to be removable for installation, service or maintenance shall be secured and require mechanical attachment.

1. Mechanical fasteners for removable components shall be indicated on shop drawings.
2. Exceptions: Items that do not require tools for removal include:

   a. Drawers.
   b. Adjustable shelves.
   c. Curtains.
   d. Threaded caps and covers.

D. Casework:

1. Set casework items square, plumb, and level. Shim as required, using concealed shims. All items shall be securely anchored.
2. Where required, assemble units into one integral unit with joints flush, tight, and uniform.
3. Provide matching filler pieces where casework abuts walls or columns, or should be closed off.

   a. All wood, Decorative Laminate, solid phenolic and polypropylene work abutting other building components shall be properly scribed.

4. Mechanical fasteners used at exposed and semi-exposed surfaces, excluding installation attachment screws and those securing cabinets end to end, shall be countersunk.
5. Cutouts for equipment, mechanical, electrical or plumbing services shall be made by the casework manufacturer or casework installer.
6. Install hardware uniformly and precisely. Set hinges snug and flat in mortises. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly and correctly, and so that doors and drawers operate without warp or bind and contact points meet accurately.
7. Secure base cabinets to service struts and ledging, partition framing, wood blocking, or

reinforcements in partitions with fasteners spaced not more than 24 inches [610mm] on center. Bolt adjacent floor mounted cabinets together with joints flush, tight, and uniform.

8. Floor mounted casework shall receive top set or integral base as specified under Division 09 and on the Finishes drawings.
9. Suspended Casework, Wall Cabinets, and Shelving:
    a. Fasten suspended and wall cabinets to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through the back, near top, at not less than 24 inches [610mm] on center.
    b. Securely fasten to solid supporting material; not plaster, lath, or wallboard. Anchor, adjust, and align suspended casework, wall cabinets, and shelving supports as specified for base cabinets.
    c. Blocking and backing in cavity wall construction for suspended casework, wall cabinets, and shelving shall be as specified under Division 09, and shall be installed under the scope of work of other Sections. General Contractor shall coordinate the location of in-wall blocking and backing using the shop drawings provided under this Section. Verify that all required backing and reinforcement necessary to support wall-mounted units is in place, secure, and accurately located.

E. Laboratory Tops:

1. Scribe tops as necessary for close and accurate fit.
2. Field Joints: Factory-prepared and identical to factory joints, locate only where indicated on approved Shop Drawings. Field processing of top and edge surfaces is not acceptable, except as described by manufacturer in approved Submittal Data. Provide full length, one-piece tops and backsplashes wherever possible, and keep field joints to an absolute minimum.
3. Abut top and edge surface in one true plane, with internal supports placed to prevent any deflection. Joints in top units shall be flush and the narrowest for the respective materials of construction.
4. Epoxy Resin: Cement joint in accordance with the manufacturers' specifications.
5. Stainless Steel: Field-weld joints in stainless steel tight, without open seams. Finish material to match adjacent to weld.
6. Decorative Laminate: Seal unfinished edges and cutouts in Decorative Laminate work surfaces with heavy coat of polyurethane varnish.
7. Polypropylene: Adjacent worksurface sheets shall be beveled along the top edge, continuously welded to fill bevel, and buffed smooth with the worksurface. In addition, joint between adjacent worksurface sheets shall be continuously welded from below.

F. Tolerances: Casework shall not exceed the following tolerances:

1. Variation of Bottoms of Wall Cabinets from Level: 1/8 inch in 10 ft.
2. Variation of Cabinet Faces from a True Plane: 1/8 inch in 10 ft.
3. Variation of Adjacent Surfaces from a True Plane: 1/32 inch.
4. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
5. Variation of Work Surfaces from Level: 1/16 inch in 10 ft.

G. Laboratory Sinks:

1. Epoxy Resin, Undermount: Sinks shall be set in work surface with chemical-resisting sealing compound, secured and supported in accordance with manufacturer's instructions. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.
2. Epoxy Resin, Drop In: Set sink in adhesive and fill remainder of rabbet with sealant or adhesive. Use procedures recommended by sink and work surface manufacturers.

Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

3. Epoxy Resin and Polypropylene Cup Sinks, Drop In: Set sink in adhesive and fill remainder of rabbet with sealant or adhesive. Use procedures recommended by sink and work surface manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
4. Epoxy Resin and Polypropylene Cup Sinks, Top Mount: Set sink in adhesive. Use procedures recommended by sink and work surface manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.
5. Stainless Steel, Top Mount: Before setting, apply sink and work surface manufacturers' recommended sealant under rim lip and along work surface. Remove excess sealant while still wet and finish joint for neat appearance.

H. Miscellaneous Furnishings and Accessories:

1. Install in accordance with manufacturer's instructions.
2. Securely fasten wall mounted adjustable shelving supports, stainless steel shelves, drying racks, etc. to partition framing, wood blocking, or reinforcements in partitions.
3. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.
4. Tighten screws to seal flat; do not drive.

I. Sealant:

1. Caulk edges of tops, backsplashes and side splashes to adjacent wall surface, and around all work surface penetrations, with sealant.
2. Sealant application shall be in accordance with manufacturer's published recommendations.

J. Repair or remove and replace defective work as approved by the Architect at no additional cost to the Owner.

1. Where approved by Design Professional, touch-up finishes applied to damaged surfaces shall have a VOC content of no more than 250 g/L in accord with SCAQMD Rule #1168.

K. Adjustable Laboratory Furniture System:

1. Support system locations shall be established from approved shop drawings so that mechanical and electrical work can be installed without interfering with installation.
2. Installation of support system shall be coordinated with the trades to maintain the integrity of the installed system.
3. Support system assemblies, ancillary components and accessories shall be installed with the supervision of the manufacturer's authorized representative and according to manufacturer's recommendations.

3.4 ADJUSTING

A. Before completion of installation, the installer shall adjust all moving and operating parts to function smoothly and correctly.

B. All nicks, chips, and scratches in the finish shall be filled and retouched. Damaged items that cannot be repaired shall be replaced.

C. Replacement: Any damaged work shall be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

3.5 CLEANING

A. Clean finished units, remove any pencil and ink marks, touch up as required, and remove and refinish damaged or soiled areas.

B. Clean counter tops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

3.6 PROTECTION

A. Cover work surfaces with 1/4 inch corrugated cardboard, secured in place, after installation for protection against scratching, soiling, and deterioration during remainder of construction period. Remove protection prior to final cleaning.

B. Standing or staging work on protected or unprotected work surfaces is not allowed.

END OF SECTION 123553

SECTION 123619 – WOOD COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood countertops.

2. Shop finishing of wood countertops.

B. Related Sections include the following:

1. Division 06 "Interior Architectural Woodwork" for additional requirements.

2. Division 12 "Metal Laboratory Casework."

C. Single Source Responsibility: Refer to Division 12 Section "Laboratory Casework" for single source responsibility requirements for wood countertops.

1.3 SUBMITTALS

A. Product Data: For each type of product, including finishing materials and processes.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show locations and sizes of cutouts and holes for items installed in wood countertops.

C. Samples for Verification:

1. Lumber for transparent finish, not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.

D. Qualification Data: For fabricator.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver wood countertops until painting and similar operations that could damage wood countertops have been completed in installation areas. If wood countertops must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wood countertops until building is wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where wood countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 WOOD COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, finishes, installation, and other requirements.

B. Grade: Premium.

C. Type of Top: Solid butcher block for transparent finish. Narrow strips of lumber glued together. Arrange strips for random mix of color and grain.

1. Wood Species: Hard maple.

2. Strip Thickness: 1-1/2 inches.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 8 to 13 percent.

2.3 MISCELLANEOUS MATERIALS

A. VOC Limits for Installation Adhesives and Sealants: Use products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.

2. Multipurpose Construction Adhesives: 70 g/L.

3. Structural Wood Member Adhesive: 140 g/L.

4. Architectural Sealants: 250 g/L.

2.4 FABRICATION

A. Fabricate wood countertops to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

2. Edges of Members More Than 3/4 Inch Thick: 1/8 inch.

B. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

C. Shop-cut openings to maximum extent possible to receive hardware or other items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

2.5 SHOP FINISHING

A. General: Finish architectural wood countertops at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Finish Materials: Use finish materials that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Priming: Shop apply the prime coat including backpriming, if any, for items specified to be field finished. Refer to Section 099300 "Staining and Transparent Finishing" for material and application requirements.

D. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood countertops. Apply two coats to end-grain surfaces.

E. Transparent Finish:

1. Grade: Same as item to be finished.

2. Finish: System - 5, conversion varnish.

3. Staining: Match Architect's sample.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition wood countertops to average prevailing humidity conditions in installation areas.

B. Before installing wood countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install wood countertops to comply with same grade as item to be installed.

B. Assemble wood countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

C. Install wood countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut wood countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.

2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c.

3. Calk space between backsplash and wall with sealant specified in Section 079200 "Joint Sealants."

F. Touch up finishing work specified in this Section after installation of wood countertops. Fill nail holes with matching filler where exposed.

1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective wood countertops, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean wood countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 123619

SECTION 123661 - SOLID SURFACE AND SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-surface-material countertops and backsplashes.
2. Quartz agglomerate countertops and backsplashes.

B. Related Sections:

1. Division 05 Section “Metal Fabrications” for steel framing for countertops.
2. Division 06 Section "Rough Carpentry" for plywood substrate for countertops.
3. Division 06 Section “Interior Architectural Woodwork” for cabinetry.
4. Division 22 - various sections for plumbing hook-ups and model numbers for integral sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop materials. Submit manufacturer's specifications and installation instructions.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, dimensions, component sizes, fabrication details, attachment provisions, and coordination requirements with adjacent work. Include rough-in dimensions for mechanical trades.

1. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, and soap dispensers installed in countertops.

C. Samples for Verification: For the following products:

1. Countertop material, 6-inches square.
2. One full-size solid-surface-material countertop, with front edge and backsplash, 8 by 10-inches, of construction and in configuration specified.
3. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10-inches, of construction and in configuration specified.

1.4 INFORMATION SUBMITTALS

A. Operation and Maintenance Data: For manuals.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Engage a qualified firm to assume undivided responsibility for production and installation of countertops. Firm shall be experienced in producing countertops similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Source Limitations: Obtain each type of countertop material from a single source.

C. Source Limitations for Other Materials: Obtain each type of adhesive, accessory, sealant, and other material from a single manufacturer.

D. Mockup: Build mockup to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of typical countertop.
2. Approved mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect countertops against damage during transportation, storage, and installation until completion.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

A. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or equal:

   a. Avonite
   b. DuPont™Corian®
   c. Staron

2. Colors and Patterns: Refer to Interior Finish Legend.

B. Configuration: Provide countertops with the following front and backsplash style:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.
3. Endsplash: Matching backsplash.

C. Countertops: 3/4-inch thick, solid surface material with front edge built up with same material.

D. Backsplashes: 3/4-inch thick, solid surface material.

E. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Install integral sink bowls in countertops in shop.

2. Countertops shall be factory cored for plumbing fittings and bath accessories provided under Division 10 Section "Toilet Accessories" and Division 22 "Plumbing."

2.2 QUARTZ AGGLOMERATE COUNTERTOPS

A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI SS1, and as follows:

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or equal:

1. Cambria
2. DuPont Zodiaq®
3. Silestone

C. Colors and Patterns: Refer to Interior Finish Legend.

1. Physical Properties: Provide quartz agglomerate material with the following minimum physical property requirements when tested according to test methods indicated:

a. Absorption by Weight: 0.03 percent per ASTM C 97.
b. Density: 154 lbs/cu. ft. per ASTM C 97.
c. Compressive Strength: 29,100 psi per ASTM C 170.
d. Abrasion Resistance: 65 per ASTM C 241.
e. Flexural Strength: 5,840 psi per ASTM C 880.
f. Breaking Strength: 480 lbf per ASTM C 648.
g. Coefficient of Friction: 0.51 minimum per ASTM C 1028.
h. Thermal Shock: Passes five cycles per ASTM C 484.
i. Surface Burning: Class 1 per ASTM E 84.
j. Freeze/Thaw: 15 cycles 0 tiles per ASTM C 1026.

k. odulus of Rupture: 6,310 psi per ASTM C99.

2. Finish: Polished.

D. Configuration: Provide countertops with the following front and backsplash style:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.
3. Endsplash: Matching backsplash.

E. Countertops: 3/4-inch thick, quartz agglomerate with front edge built up with same material.

F. Backsplashes: 3/4-inch thick, quartz agglomerate.

G. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

2.3 COUNTERTOP MATERIALS

A. Bonding Adhesives for Solid Surfacing: Two part adhesive with color matching solid surfacing countertop and of type as recommended by solid surfacing countertop manufacturer for bonding solid surfacing materials together.

B. Bonding Adhesive for Quartz Agglomerate: 2-part epoxy adhesive, formulated specifically for bonding quartz agglomerate materials together, with an initial set time of not more than 2 hours at 21 deg C, and with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Color: Match quartz agglomerate.

2.4 MISCELLANEOUS MATERIALS

A. Sealants: Sanitary Silicone Sealant in one color as selected by Architect from manufacturers standards. Refer to Division 07 Section "Joint Sealants."

B. Mounting Accessories: Provide manufacturer's recommended under-mount hardware for bowls and sinks where required.

C. Steel Framing for Countertops: Refer to Division 05 Section "Metal Fabrications."

D. Plywood for Countertops: Refer to Division 06 Section "Rough Carpentry."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Verify all measurements in the field. Coordinate the work of other trades with the Work of this section.

3.3 INSTALLATION

A. Provide a competent and experienced superintendent to supervise, coordinate and expedite the Work continuously.

B. Uncrate countertops and attach to substrates where indicated. Install components plumb, true and level, scribed to adjacent finishes in accordance with the accepted shop drawings and product installation data.

1. Install countertops level to a tolerance of 3 mm in 2.4 m.

C. Form field joints, if any, using manufacturers recommended adhesive, with joints inconspicuous in finished work. Keep components and hands clean when making joints. Remove adhesives, sealants, surface scratches, and other stains. Remove and replace any stained unit which cannot be cleaned.

D. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

1. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
2. Seal edges of cutouts in plywood substrates by saturating with varnish.

E. Make plumbing connections to lavatories in accordance with Division 22 work.

F. Prepare joints and place sealants as indicated and specified in Division 07 Section "Joint Sealants."

3.4 ADJUSTING AND CLEANING

A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive and sealant smears immediately.

B. Remove and replace solid surfacing and simulated stone countertops of the following description:

1. Broken, chipped, stained, or otherwise damaged.
2. Defective joints, including misaligned joints.
3. Countertops and joints not matching approved Samples and mockups.
4. Countertops not complying with other requirements indicated.

C. Replace in a manner resulting in solid surfacing and simulated stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.

D. Clean solid surfacing and simulated stone countertops not less than six days after completion of sealant installation, using clean water and soft rags and according to Manufacturer’s instructions. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.

E. At a time as approved by the Architect, remove all temporary protection and leave the installation clean and free of any imperfections.

END OF SECTION 123661

SECTION 125713 - WELDING FUME EXHAUST SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
1. Welding fume exhaust system and controls.
2. Accessories.
3. Additional System Equipment.
4. Manufacturer’s commissioning.

B. Related Sections:
1. Division 01 “Commissioning.”
2. Division 23 HVAC Sections - Furnishing and installation of mechanical utilities and final connections to equipment.
3. Division 26 “Electrical Sections for furnishing and installing electrical connections.

1.3 PERFORMANCE REQUIREMENTS

A. Engineered Submittals: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to provide structural calculations and detailed shop drawings welding fume exhaust system.

B. Galvanized Steel Duct Work:
1. Furnish and install associated galvanized steel duct work to provide a completely engineered duct system with a balanced amount of airflow to each work station.
2. Ductwork shall be designed in accordance with “Industrial Ventilation: A Manual of Recommended Practice for Design” by ACGIH and designed and installed in accordance with “Accepted Industry Practice for Industrial Duct Construction” by SMACNA.

1.4 SUBMITTALS

A. Product Data for new equipment:
1. Manufacturer's model number.
2. Accessories and components.
3. Clearance requirements for access and maintenance.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Shop drawings that include elements engineered by the fabricator must be signed and sealed by a professional engineer licensed in the State of Florida. When the professional engineer has not directed the process of the shop drawings, a signed and sealed cover letter shall be submitted along with the shop drawings substantiating the engineering

information. The professional engineer shall review the shop drawings and confirm in this cover letter that the shop and erection drawings properly incorporate the engineering criteria.

C. Coordination Drawings:
1. Indicate locations of welding benches and connections to utilities.
2. Key equipment using same designations as indicated on Drawings.
3. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
4. Include details of seismic bracing for equipment.

D. Warranty: Samples of special warranty.

E. Installation Drawings:
1. Installation Drawings are a required informational submittal.
2. Contractor shall provide manufacturer's installation drawings to HVAC contractor(s) for the purpose of including this information in the Coordination Drawings specified under Divisions 22, 23, and 26, and coordinate as required to ensure that this information is communicated in an accurate and timely manner.

F. Maintenance Data:
1. Provide complete data for incorporation into operations and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: Welding Fume Exhaust System equipment and accessories shall be manufactured and furnished by a single manufacturer.

B. Manufacturer's Qualifications: Modern plant with proper tools, dies, fixtures and skilled workmen to produce high quality equipment; and shall meet the following minimum requirements:
1. Five years or more experience in the manufacture of welding exhaust systems and equipment of type specific.
2. Ten installations of equal or larger size and requirements. Provide contact and references for each.

C. Installer's qualifications: Factory certified by the manufacturer. Provide outline of certification program.

D. Seismic Restraints: Comply with applicable Codes.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with laboratory equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of equipment so that spaces are sufficiently complete and equipment can be installed immediately following delivery.

B. Protect finished surfaces from soiling or damage during handling and installation. Equipment is to be stored indoors until time of installation.

1.8 FIELD CONDITIONS

A. Locate concealed framing, blocking, and reinforcements that support welding fume exhaust system by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.9 COORDINATION

A. Coordinate welding fume exhaust system layout and installation with other work, including:
   1. Layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.
   2. Locations and requirements of utility service connections.
   3. Laboratory casework.

1.10 COMMISSIONING

A. Provide system start-up, commissioning, and technician support to test and tune the system at initial system operation. Commissioning includes manual damper adjustment, airflow set point, extraction system operation and maintenance. Post installation commissioning include a point-to-point checklist and sign-off procedure. Provide one factory technician.

B. Technician shall be on-site and present at the time of start-up of the system. System shall not be used to test the leakage of ductwork or to test electrical connections, wiring or compressed air system.

C. Commissioning data and reports are for the purpose of warranting the system by the manufacturer.

PART 2 - PRODUCTS

2.1 WELDING FUME EXHAUST SYSTEM

A. Manufacturers:

   1. Kemper America
   2. (Basis of Design) Lincoln Electric Fume Control
   3. Nederman

2.2 COMPONENTS AND PRODUCT DESCRIPTION

A. The following components and products are based on Lincoln Electric Fume Control system.
   1. See division 23 for additional components.

LTA 2.0-CW	TELESCOPIC ARM Wall mounted telescopic articulating fume extraction arm with 360 deg. rotating hood. The working radius ranges from 3' to 7'. The nominal diameter of the arm is 8 inches. Spring balance and counterweight allow arm to maintain position. Adjustable throttling valve is in hood. The arm is designed to be positioned 6-12" away from the welding process.
K1657-5	CONNECTOR, 8" DUCT - EXTRACTION ARM The polypropylene Connector bolts to the top of the extraction arm and allows for easy connection of the duct drop when used in a central system.
S28367-16	MANUAL DAMPER 8", MD8 The manual damper is used to balance the air flow at each fume extraction arm. It is located between the arm and the duct main. The damper is made from galvanized steel, and is 8 inches in diameter with EPDM rubber seal.
AD1389-2	FILTER, PRESSURE DIFFERENTIAL KIT Monitors the saturation level of the filter cartridges and adjusts the air volume rate based upon a predetermined setpoint. As filter cartridges become saturated, the controller adjusts the fan speed to maintain the required air volume determined by the air volume setpoint. Kit shall include (1) S23385-48 Pressure Gauge Gauge enclosure NEMA 4X
AD1283-46	A. ENV,POWERFLEX 400,40HP,64AMP,IP54VFD B. The variable frequency drive (VFD) regulates the fan input voltage based on either a differential pressure signal or a signal from the IF-15 control box. UL listed to UL508C, NEMA ICS 3.1, IEC 146. C. Electrical Specifications: D. Voltage Tolerance 200-240V +or- 10%

	E. 380-480V +or- 10% F. Frequency Tolerance 48-63 Hz G. Input phases 3 phase = full rating. De-rate for single phase. H. Displacement pf 0.98 across entire speed range I. Efficiency 97.5% @ rated amps, nominal line voltage J. K. Environment: L. Altitude 3300ft without derating M. Air Temp IP20,NEMA/UL type open = -10 to 50 deg C. Humidity 0-95% non-condensing
AD1389-3	N. ON/OFF PUSH BUTTON CONTROLLER O. Kit includes the following: P. Q. (1) – S21118-91 Enclosure R. (1) – S21130-21 Green Push Button, AB S. (1) – S21130-46 Red Push Button, AB (1) – S22628-5 Push Button, contact block, 2 N.C.
S21118-91	ENCLOSURE, 2 ELEMENT, STEEL 30.5mm, Heavy-Duty, Pilot Device Enclosure, Gray, Steel, Surface Mount, 2 Element, 1 Contact Block Depth, NEMA 12, 13.
S21130-21	PUSH BUTTON, 30mm Push button, 30.5mm, Green, Type 4x, IP65 wateright/oiltight panel, Double nickel plated terminal screws, Contact material: Silver
S21130-46	FLUSH PUSHBUTTON, 30mm Flush pushbutton, 30.5mm, Non-Illuminated, Red, 800T, NEMA Rating: 4/13, 1 NO
S22628-5	30mm CONTACT BLOCK, 1 N.C.

	1 N.C. Contact Block, 30.5 mm, Base Mount, Non-Metallic, 800T Series
S23273-6	ENV, CTRL BOX FB, PRESSURE, UP TO 24 CART The Cont-C24 monitors filter pressure and ensures cleaning is done only when necessary reducing the compressed air usage.
KP3369-1	FILTER-MERV 16 STATIFLEX FILTER BANK The Cart-MB filter media is an 80/20 blend (Cellulose/Spun Bond Polyester) with a Nano fiber overlay. Each cartridge is created using a pleat stabilizing technique that ensures correct distances between cartridge pleats. This allows for more “effective” filter area resulting in better cleaning efficiency. The result is a lower cartridge replacement rate. This filter has a MERV-16 rating based on the ASHRAE 52.2 test.
XCUSTOM_ITEM	UTOMATIC CONTROLS & ELECTRONICS Equipment required to convert the system to fully controlled automatic operation using lamp/arc sensor technology. These items include (20) AD1221 – LAMP/ARC SENSOR KIT (20) S28367-2 – 8” AUTOMATIC DAMPERS (2) S23385-IF15 – INTERFACE CONTROL (1) G3207-303 - PLC Automatic control provide energy efficiency and energy use savings by means of on demand operation and reduces maintenance through reduction in activation as compared to a typical on-off manual system or a 100% constant system operation.
AD1221	LAMP/ARC SENSOR KIT This kit incorporates a lamp, sensor, and on/off switch; such that an operator may turn the fan on/off manually or automatically right at the end of the arm. The sensor will turn the fan on when it detects the arc, and off when it no longer detects the arc. The following items are included in the kit: Work lamp, arc sensor, 36’- 3 wire - 20 AWG, control box, and thermal relay.

	Specs. Voltage 24 VAC Bulb Halogen, 35W Weight 7.7 lbs
S28367-2	IF-15 INTERFACE CONTRL The IF-15 works in conjunction with the VFD to regulate the fan speed based on the number of arms that are demanding air flow. The IF-15 receives a signal from the fume extraction arm to turn the fan on/off, and/or to change its frequency (speed). The signal output to the VFD is 4-20mA. The input power required to the IF-15 is 24V AC. The IF-15 can serve up to 15 arms. More than one IF-15 can be wired to the VFD as necessary.
G3207-303	PLC, 2-4 IF 15 Connections Used to combine the output from up to four IF-15 interface devices into one 4-20ma signal, which is fed into the variable frequency drive.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect and verify that all necessary utilities have been roughed in prior to equipment installation.

3.2 INSTALLATION

A. Install welding fume extraction system and equipment in accordance with the manufacturer's instructions.
   1. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
   2. Secure equipment components with material and procedures recommended by the manufacturer.
   3. Install ductwork in accordance with Accepted Industry Practice for Industrial Duct Construction by SMACNA.

B. Accessory installation: Install all accessories and fittings in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL TESTING OF WELDING FUME EXTRACTION SYSTEM

A. Field testing requirements:

1. Perform tests in field to verify proper operation of the system before they are put in use, using only qualified personnel.
2. Correct any unsafe conditions disclosed by these tests before request of test procedures.
3. Commissioning and balancing of the fan, VFD, and fume extraction arms shall be completed by manufacturer’s technician.

3.4 CLEANING AND PROTECTING

A. Clean and adjust equipment as required to produce ready-for-use condition.

B. Protect equipment from damage during remainder of the construction period.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain laboratory equipment.

END OF SECTION 125713

SECTION 142400 - MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Machine Room-Less (MRL) Electric Traction elevators as shown and specified as follows:
   1. Two (2) Passenger-Service Shape Elevators, Cars E1-E2.
   2. Elevator work includes:
      a. Standard pre-engineered MRL Traction elevators.
      b. Elevator car enclosures, hoistway entrances and signal equipment.
      c. Operation and control systems.
      d. Counterweights & Guide Rails.
      e. Accessibility provisions for physically disabled persons.
      f. Equipment, machines, controls, systems and devices as required for safely operating the specified elevators at their rated speed and capacity.
      g. Materials and accessories as required to complete the elevator installation.

   3. Machine Room-Less Traction Elevators that comply with the intent of the specifications will be considered as an equivalent.

B. Related Requirements:
   1. Division 1 General Requirements: Meet or exceed all referenced sustainability requirements.
   2. Division 01 Section “Temporary Facilities and Controls” for temporary use of elevators for construction purposes.
   3. Division 03 Section “Cast-in-Place Concrete” for setting sleeves, inserts, and anchoring devices in concrete.
   4. Division 5 Metals:
      a. Providing hoist beams, pit ladders, steel framing, auxiliary support steel and divider beams for supporting guide-rail brackets.
      b. Providing steel angle sill supports and grouting hoistway entrance sills and frames.
   5. Division 9 Finishes: Providing elevator car finish flooring and field painting unfinished and shop primed ferrous materials.
   6. Division 26 Sections:
      a. Providing electrical service to elevators, including fused disconnect switches where permitted. (note: fused disconnect switch to be provided as part of elevator manufacture product, see section 2.11 Miscellaneous elevator components for further details.)
      b. Emergency power supply, transfer switch and auxiliary contacts.
      c. Heat and smoke sensing devices.
      d. Convenience outlets and illumination in control room (if applicable), hoistway and pit.
   7. Division 22 Plumbing
      a. Sump pit and oil interceptor.
   8. Division 23 Heating, Ventilation and Air Conditioning
      a. Heating and ventilating hoistways and/or control room.

C. To discover and resolve conflicts or lack of definition which might create problems, Contractor must review Contract Documents and site conditions for compatibility with its product prior to submittal of quotation. Review existing structural, electrical, and mechanical provisions for compatibility with Contractor's products. Purchaser will not pay for change to structural, mechanical, electrical, or other systems required to accommodate Contractor's equipment.

1.2 REFERENCES

A. Definitions: Terms used are defined in the latest edition of the Safety Code for Elevators and Escalators, ASME A17.1.

B. American National Standard Institute (ANSI):
   1. A117.1 - Accessible and Usable Buildings and Facilities

C. American Society of Mechanical Engineers:
   1. ASME A17.1 - Safety Code for Elevators and Escalators.

D. ASTM International:
   1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
   2. ASTM A240

E. National Fire Protection Association (NFPA)
   1. NFPA 101 – Life Safety Code

1.3 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems. Include product data for signal fixtures, lights, graphics, Braille plates, and details of mounting provisions.

B. Shop Drawings:
   1. Include plans, elevations, sections, and large-scale details indicating openings at each landing, Control room layout, coordination with building structure, relationships with other construction, and locations of equipment.
   2. Indicate elevator system capacities, sizes, performances, safety features, finishes and other pertinent information.
   3. Include large-scale layout of car operating panel and standby power operation control panel.
   4. Indicate maximum dynamic and static loads imposed on building structure at points of support and maximum and average power demands.
   5. Power Confirmation Information: Include motor horsepower, code letter, starting current, full-load running current, and demand factor. Provide maximum and average power consumption.

C. Samples for Initial Selection: For finishes involving surface treatment, paint or color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes:
   1. Samples of sheet materials: 3" (75 mm) square.
   2. Running trim members: 4" (100 mm) lengths.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. For elevators to include in emergency, operation, and maintenance manuals.
   2. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include diagnostic and repair information available to manufacturer’s and Installer’s maintenance personnel.
   3. Wiring diagrams and Parts list, with recommended parts inventory

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.5 QUALITY ASSURANCE

A. Compliance with Regulatory Agencies: Comply with most stringent applicable provisions of the following regulatory requirements, codes, laws, and/or authorities having jurisdiction, including revisions and changes in effect:

B. Manufacturer Qualifications: An approved manufacturer with minimum 15 years of experience in manufacturing, installing, and servicing elevators of the type required for the project.
   1. The manufacturer of machines, controllers, signal fixtures, door operators cabs, entrances, and all other major parts of elevator operating equipment.
      a. The major parts of the elevator equipment shall be manufactured by the installing company, and not be an assembled system.
   2. The manufacturer shall have a documented, on-going quality assurance program.
   3. ISO-9001:2000 Manufacturer Certified
   4. ISO-14001:2004 Environmental Management System Certified
      LEED Gold certified elevator manufacturing facility.

C. Installer Qualifications: The manufacturer or an authorized agent of the manufacturer with not less than 15 years of satisfactory experience installing elevators equal in character and performance to the project elevators.

D. Regulatory Requirements:
   1. ASME Safety Code for Elevators and Escalators, latest edition or as required by the local building code.
      a. ASME A17.1
      b. ASME A17.2
      c. ASME A17.5
   2. Building Code: 2017 FBC (Sixth Edition)
   3. Florida Fire Prevention Code
      a. NFPA101
   4. NFPA 70 National Electrical Code.
   5. NFPA 80 Fire Doors and Windows.
   6. Americans with Disabilities Act - Accessibility Guidelines (ADAAG)
   7. Section 407 in ICC A117.1, when required by local authorities

E. Fire-rated entrance assemblies: Opening protective assemblies including frames, hardware, and operation shall comply with ASTM E2074, UL10(b), and NFPA Standard 80. Provide entrance assembly units bearing Class B or 1 1/2 hour label by a Nationally Recognized Testing Laboratory

F. Inspection and testing:
   1. Elevator Installer shall obtain and pay for all required inspections, tests, permits and fees for elevator installation.
   2. Arrange for inspections and make required tests.

3. Deliver to the Owner upon completion and acceptance of elevator work.

G. Sustainable Product Qualifications:
1. Environmental Product Declaration:
   a. GOOD: If Product Category Rules (PCR) are not available, produce a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate scope.
   b. BEST: If Product Category Rules (PCR) are available, produce and publish an Environmental Product Declaration (EPD) based on a critically reviewed life-cycle assessment conforming to ISO 14044, with external verification recognized by the EPD program operator.
2. Material Transparency:
   a. GOOD: Provide Health Product Declaration at any level
   b. BETTER: Provide Health Product Declaration (HPD v2 or later). Complete, published declaration with full disclosure of known hazards, prepared using the Health Product Declaration Collaborative's "HPD builder" on-line tool.
   c. BEST: Cradle to Cradle Material Health Certificate v3, Bronze level or higher.
3. LEED v4 – Provide documentation for all Building Product Disclosure AND Optimization credits in LEED v4 for product specified.
4. Living Building Challenge Projects: Provide Declare label for products specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in Contractor’s original unopened protective packaging.

B. Store material in original protective packaging. Prevent soiling, physical damage, or moisture damage.

C. Protect equipment and exposed finishes from damage and stains during transportation and construction.

1.7 WARRANTY

A. Manufacturer’s Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

B. Failures include, but are not limited to: operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

C. Warranty Period: One year from date of Substantial Completion.

1.8 MAINTENANCE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall provide twelve months full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.

1. Perform maintenance during normal working hours.
2. Perform emergency callback service during normal working hours. Include emergency callback service with response time of sixty minutes or less.
3. Construction contract will include initial maintenance service beginning at Substantial Completion. Owner/General Contractor cannot deduct.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kone Inc, Monospace 500 (Basis of Design)
   2. ThyssenKrupp Elevator, Evolution 200
   3. Schindler, 3300 XL
   4. Otis Elevator Co, GEN2.

B. Approved Components:
   1. Hoistway Entrance: KONE, Otis, Schindler, ThyssenKrupp, Tyler, Mitsubishi.
   2. Fixtures Traditional & Vandal-resistant.

2.2 ELEVATORS

A. Description: MRL Electric Traction Elevators (Service Shape)
   1. Elevator Qty: #2
   2. Elevator Identification: Cars E1-E2
      5. Elevator Model: Monospace® 500
      6. Elevator Type: Machine Room-Less, Electric Traction
      7. Rated Capacity: 5000 lbs. (Alternate : 4500 lbs minimum)
      8. Class of Loading: Class A
      9. Rated Speed Range: 150 fpm – 200fpm
      10. Machine: Gearless
      11. Machine Location: Overhead in hoistway
      12. Counterweight location: Side
      13. Operation System: Supervisory Control, Group automatic
      14. Equipment Control: KCM831
      15. Drive: Regenerative
      16. Travel: 16'-0"
      17. Landings: 2 total
      18. Openings: Front #1
      19. Clear Car Inside: 5' - 7" wide x 8' - 10" deep
      20. Cab Height: 9'-0" standard
      21. Hoistway Entrance Size: 4'-0" wide x 8'-0" high
      22. Door Type: Two Speed
      23. Power Characteristics: 480 volts +/_ 5%, 3 Phase, 60 Hz.
      24. Seismic Requirements: N/A
      25. Hoistway Dimensions: 7' - 8" wide x 10' - 4" deep
      26. Pit Depth: 5' - 0"
      27. Button & Fixture Style: Traditional Signal Fixtures
      28. Special Operations: None

29. Dimensional changes: Design requires dimensions shown in drawings. Any changes to hoistway size or overhead must be submitted for review before approval.

2.3 MATERIALS

A. Steel:
   1. Sheet Steel (Furniture Steel for Exposed Work): Stretcher-leveled, cold-rolled, commercial quality carbon steel, complying with ASTM A366, matte finish.
   2. Sheet Steel (for Unexposed Work): Hot-rolled, commercial quality carbon steel, pickled and oiled, complying with ASTM A568/A568M-03.
   3. Structural Steel Shapes and Plates: ASTM A36.

B. Stainless Steel: Type 302 or 304 complying with ASTM A240, with standard tempers and hardness required for fabrication, strength, and durability. Apply mechanical finish on fabricated work in the locations shown or specified, Federal Standard and NAAMM nomenclature, with texture and reflectivity required to match Architect's sample. Protect with adhesive paper covering.
   1. No. 4 Satin: Directional polish finish. Graining directions as shown or, if not shown, in longest dimension.
   2. No. 8 Mirror: Reflective polish finish with no visible graining.
   3. Textured: .050 inches mean pattern depth with bright directional polish (No. 4 satin finish).
      a. 5WL as manufactured by Rigidized Metals.
      b. Windsor pattern as manufactured by Rimex Metals.
   4. Burnished: Non-directional, random abrasion pattern.

C. Aluminum: Extrusions per ASTM B221; sheet and plate per ASTM B209.

D. Plastic Laminate: ASTM E84 Class A and NEMA LD3.1, Fire-Rated Grade (GP-50), Type 7, 0.050" ±.005" thick, color and texture as follows:
   1. Exposed Surfaces: Color and texture selected by Architect.
   2. Concealed Surfaces: Manufacturer's standard color and finish.

E. Fire-Retardant Treated Particle Board Panels: Minimum 3/4" thick backup for natural finished wood and plastic laminate veneered panels, edged and faced as shown, provided with suitable anti-warp backing; meet ASTM E84 Class "I" rating with a flame-spread rating of 25 or less, registered with Local Authorities for elevator finish materials.

F. Natural Finish Wood Veneer: Standard thickness, 1/40" thoroughly dried conforming to ASME/HPMA HP-1983, Premium Grade. Place veneer, tapeless spliced with grain running in direction shown, belt, and polish sanded, book-matched.

G. Paint Finishes, General: Clean exposed metal parts and assemblies of oil, grease, scale, and other foreign matter and factory paint one shop coat of standard rust-resistant primer. Galvanized metal need not be painted.
   1. Prime Finish: Apply one coat of rust-resistant primer followed by a filler coat over uneven surfaces. Sand smooth and apply final coat of primer.

H. Baked Enamel Finish: Prime finish per above. Unless specified "prime finish" only, apply and bake three additional coats of enamel in the selected solid color.

2.4 HOISTWAY ENTRANCES

A. Complete entrances bearing fire labels from a certified testing laboratory approved by authority having jurisdiction.

B. Doors and Frames: Provide complete hollow metal type hoistway entrances at each hoistway opening bolted\knock down construction.
   30. Manufacturer's standard entrance design consisting of hangers, doors, hanger supports, hanger covers, fascia plates (where required), sight guards, and necessary hardware.
   31. Main landing door & frame finish: Stainless steel panels, no. 4 brushed finish.
   32. Typical door & frame finish: Stainless steel panels, No. 4 brushed finish.

B. Integrated Control System: the elevator controller to be mounted to hoistway entrance above 1st landing. The entrance at this level, shall be designed to accommodate the control system and provide a means of access to critical electrical components and troubleshooting features. See section 2.09 Control System for additional requirements.

C. At the controller landing, the hoistway entrance frame shall have space to accommodate and provide a lockable means of access (group 2 security) to a 3 phase circuit breaker. See section 2.11 Miscellaneous Elevator Components for further details

D. Interlocks: Equip each hoistway entrance with an approved type interlock tested as required by code. Provide door restriction devices as required by code.

E. Door Hanger and Tracks: Provide sheave type two point suspension hangers and tracks for each hoistway horizontal sliding door.
   1. Sheaves: Polyurethane tires with ball bearings properly sealed to retain grease.
   2. Hangers: Provide an adjustable device beneath the track to limit the up-thrust of the doors during operation.
   3. Tracks: Drawn steel shapes, smooth surface and shaped to conform to the hanger sheaves.

F. Hoistway Sills: Extruded metal, with groove(s) in top surface. Provide mill finish on aluminum.

G. Elevator Identification Signage: Provide alpha-numerical car label at designated floor. Provide metal plate, finish to match designated fixture finish.

H. Finish of Frames and Doors: Satin finish stainless steel.

2.5 HOISTWAY EQUIPMENT

A. Platform: Fabricated frame of formed or structural steel shapes, gusseted and rigidly welded with a wood sub-floor. Underside of the platform shall be fireproofed. The car platform shall be designed and fabricated to support one-piece loads weighing up to 25% of the rated capacity.

B. Sling: Steel stiles bolted or welded to a steel crosshead and bolstered with bracing members to remove strain from the car enclosure.

C. Guide Rails: Steel, omega shaped, fastened to the building structure with steel brackets.

D. Guides: Slide guides shall be mounted on top and bottom of the car.

E. Buffers: Provide substantial buffers in the elevator pit. Mount buffers on continuous channels fastened to the elevator guide rail or securely anchored to the pit floor. Provide extensions if required by project conditions.

F. Automatic Self-Leveling: Provide each elevator car with a self-leveling feature to automatically bring the car to the floor landings and correct for over travel or under travel. Self-leveling shall, within its zone, be automatic and independent of the operating device. The car shall be maintained approximately level with the landing irrespective of its load.

G. Communication System:
1. Two-way communication instrument in car with automatic dialing, tracking, and recall features, with shielded wiring to car controller in equipment space. Provide dialer with automatic rollover capability with minimum two numbers.
   a. Actuate two-way communication via “Help” button.
   b. Button or adjacent light jewel shall illuminate and flash when call is acknowledged.
   c. Button shall match car operating panel pushbutton design.
   d. Provide “Help” button tactile symbol, engraved signage, and Braille adjacent to button mounted integral with car front return panel.
2. Firefighters’ communication jack in car and firefighters’ panel jack bezel shall match adjacent controls.
3. Install remote speakers provided under Item 1.1. E.1 in car canopy with drilled speaker pattern, with shielded wiring to equipment space junction box.
4. Provide two-way communication between car and equipment space if required.

2.6 CAR ENCLOSURE

A. Car Enclosure:
1. Walls: Cab type a steel shell design, reinforced cold-rolled steel. The walls shall be constructed of stainless steel, No. 4 brushed finish.
2. Reveals and frieze: Not applicable
3. Canopy: Cold-rolled steel with hinged exit.
4. Ceiling: Downlight type, metal pans with suspended LED downlights and dimmer switch. Number of downlights shall be dependent on platform size with a minimum of six. The metal pans shall be finished with a stainless steel, no. 4 brushed finish.
5. Cab Fronts, Return, Transom, Soffit and Strike: Provide panels faced with No. 4 brushed stainless steel
6. Doors: Horizontal sliding car doors reinforced with steel for panel rigidity. Hang doors on sheave type hangers with polyurethane tires that roll on a polished steel track and are guided at the bottom by non-metallic sliding guides.
   a. Door Finish: Stainless steel panels: No. 4 brushed finish.
   b. Cab Sills: Extruded aluminum, mill finish.
7. Handrail: Provide 1.5" diameter cylindrical metal on side and rear walls on front opening cars and side walls only on front and rear opening cars. Handrails shall have a stainless steel, No. 4 brushed finish.
8. Ventilation: Manufacturer’s standard exhaust fan, mounted on the car top.
9. Protection pads and buttons: Provide one set of vinyl protection pads with metal grommets for the project. Provide pad buttons on cab front(s) and walls.

B. Car Top Inspection: Provide a car top inspection station with an “Auto-Inspection” switch, an "emergency stop" switch, and constant pressure "up and down" direction and safety buttons to make the normal operating devices inoperative. The station shall give the inspector complete control of the elevator. The car top inspection station shall be mounted in the door operator assembly.

2.7 DOOR OPERATION

A. Door Operation: Provide a direct or alternating current motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. The door control system shall be digital closed loop and the closed loop circuit shall give constant feedback on the position and velocity of the elevator door. The motor torque shall be constantly adjusted to maintain the correct door speed based on its position and load. All adjustments and setup shall be through the computer based service tool. Door movements shall follow a field programmable speed pattern with smooth acceleration and deceleration at the ends of travel. The mechanical door operating mechanism shall be arranged for manual operation in event of power failure. Doors shall automatically open when the car arrives at the landing and automatically close after an adjustable time interval or when the car is dispatched to another landing. AC controlled units with oil checks, or other deviations are not acceptable.

1. No Un-Necessary Door Operation: The car door shall open only if the car is stopping for a car or hall call, answering a car or hall call at the present position or selected as a dispatch car.
2. Door Open Time Saver: If a car is stopping in response to a car call assignment only (no coincident hall call), the current door hold open time is changed to a shorter field programmable time when the electronic door protection device is activated.
3. Double Door Operation: When a car stops at a landing with concurrent up and down hall calls, no car calls, and no other hall call assignments, the car door opens to answer the hall call in the direction of the car's current travel. If an onward car call is not registered before the door closes to within 6 inches of fully closed, the travel shall reverse and the door shall reopen to answer the other call.
4. Nudging Operation: The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If door closing is prevented for a field programmable time, a buzzer shall sound. When the obstruction is removed, the door shall begin to close at reduced speed. If the infra-red door protection system detects a person or object while closing on nudging, the doors shall stop and resume closing only after the obstruction has been removed.
5. Door Reversal: If the doors are closing and the infra-red beam(s) is interrupted, the doors shall reverse and reopen. After the obstruction is cleared, the doors shall begin to close.
6. Door Open Watchdog: If the doors are opening, but do not fully open after a field adjustable time, the doors shall recycle closed then attempt to open six times to try and correct the fault.
7. Door Close Watchdog: If the doors are closing, but do not fully close after a field adjustable time, the doors shall recycle open then attempt to close six times to try and correct the fault.
8. Door Close Assist: When the doors have failed to fully close and are in the recycle mode, the door drive motor shall have increased torque applied to possibly overcome mechanical resistance or differential air pressure and allow the door to close.

B. Door Protection Device: Provide a door protection system using microprocessor controlled infra-red light beams. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen.

2.8 CAR OPERATING STATION

A. Car Operating Station, General: The main car control in each car shall contain the devices required for specific operation mounted in an integral swing return panel requiring no applied faceplate. Wrap return shall have a No. 4 brushed stainless steel finish. The main car operating panel shall be mounted in the return and comply with handicap requirements. Pushbuttons that illuminate using long lasting LED's shall be included for each floor served, and emergency buttons and switches shall be provided per code. Switches for car light and accessories shall be provided.

B. Emergency Communications System: Integral phone system provided.

C. Auxiliary Operating Panel: Not Required

D. Column Mounted Car Riding Lantern: Not required for this application.

E. Special Equipment: Not Applicable

2.9 CONTROL SYSTEMS

A. Controller: Shall be integrated in a hoistway entrance jamb. Should be microprocessor based, software oriented and protected from environmental extremes and excessive vibrations in a NEMA 1 enclosure. Control of the elevator shall be automatic in operation by means of push buttons in the car numbered to correspond to floors served, for registering car stops, and by "up-down" push buttons at each intermediate landing and "call" push buttons at terminal landings.

B. Service Panel – to be located outside the hoistway in the controller entrance jamb and shall provide the following functionality/features:
   1. Access to main control board and CPU
   2. Main controller diagnostics
   3. Main controller fuses
   4. Universal Interface Tool (UIT)
   5. Remote valve adjustment
   6. Electronic motor starter adjustment and diagnostics
   7. Operation of pit motorized shut-off valve with LED feedback to the state of the valve in the pit
   8. Operation of auxiliary pump/motor (secondary hydraulic power source)
   9. Operation of electrical assisted manual lowering
   10. Provide male plug to supply 110VAC into the controller
   11. Run/Stop button

C. Automatic Light and Fan shut down: The control system shall evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.

D. Emergency Power Operation: (Group 10-D4A) Upon loss of normal power, building-supplied standby power or Battery Power Lowering technology must be available to the elevator on the same wires as the normal power. Once the loss of normal power has been detected and standby power is available, one elevator at a time from each group will be lowered to a pre-designated landing and will open the doors. After passengers have exited the elevator, the doors are closed and the car shuts down. The next available car in the group will then be selected to lower, allow passengers to exit, close the doors and shutdown. This process is repeated until all cars in the group have been lowered and parked. At this time, an elevator is automatically allowed to continue service using the building-supplied standby power. A manual selection switch is available to override the automatic selection and allow and car in the group to provide service to the building. When normal power is restored, the elevators automatically resume operation.

E. Special Operation: Not Applicable

2.10 HALL STATIONS

A. Hall Stations, General: Buttons shall illuminate to indicate call has been registered at that floor for the indicated direction.

12. Provide one pushbutton riser with faceplates having a No. 4 brushed stainless steel finish.
    a. Phase 1 firefighter's service key switch, with instructions, shall be incorporated into the hall station at the designated level.

B. Floor Identification Pads: Provide door jamb pads at each floor. Jamb pads shall comply with Americans with Disabilities Act (ADA) requirements.

C. Hall Position Indicator: An electronic dot matrix position indicator shall be provided and mounted for optimum viewing. As the car travels, its position in the hoistway shall be indicated by the illumination of the alphanumeric character corresponding to the landing which the elevator is stopped or passing. When hall lanterns are provided, the position indicator shall be combined with the hall lanterns in the same faceplate. Faceplates shall match hall stations. Provide at all typical landings.

D. Hall lanterns: A hall lantern with adjustable chime shall be provided at each landing and located adjacent to the entrance. The lanterns, when illuminated, shall indicate the elevator car that shall stop at the landing and in what direction the car is set to travel. When the car reaches a predetermined distance from the floor where it is going to stop, the corresponding hall lantern shall illuminate and the chime shall sound. The hall lantern shall remain illuminated until the car doors close in preparation for leaving the floor. Illumination of the arrow shall be with LED's. Faceplates shall match the hall station finish. Provide at all typical landings.

E. Special Equipment: Not Applicable

2.11 MISCELLANEOUS ELEVATOR COMPONENTS

A. Lockable three phase circuit breaker with auxiliary contact with shunt trip capability to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb and should be sized according to the National Electrical Code.

B. Lockable single phase 110V circuit breaker for cab light and fan to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb should be sized according to the National Electrical Code

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to beginning installation of equipment examine hoistway and equipment space areas. Verify no irregularities exist that affect execution of work specified.

B. Verify electrical power location and characteristics in coordination with equipment requirements.

C. Verify Hoistway projections and conditions before installation

D. Do not proceed with installation until work in place conforms to project requirements.

3.2 INSTALLATION

A. Install all equipment in accordance with Contractor’s instructions, referenced codes, specification, and approved submittals.

B. Install equipment space equipment with clearances in accordance with referenced codes and specification.

C. Install all equipment so it may be easily removed for maintenance and repair.

D. Provide any required hoisting/safety beams. Remove if beams are encroaching on code clearances prior to final acceptance.

E. Install all equipment to afford maximum accessibility, safety, and continuity of operation.

F. Remove oil, grease, scale, and other foreign matter from all equipment and apply one coat of field-applied machinery enamel for all equipment and metal work installed that does not have a factory applied paint or architectural finish. Neatly touch up damaged factory-painted surfaces with original paint color to protect factory finished surfaces against corrosion.

G. Fill hoistway door frames, back boxes for hallway stations and signal devices, and sills.

H. Clean all architectural finishes and replace or restore any surfaces damaged during construction to like new condition.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

C. Independent Testing by Owner’s Consultant:

3.4 ERECTION TOLERANCES

A. Install rails plumb and align vertically with tolerance of 1/16" in 100'-0". Secure joints without gaps and file any irregularities to a smooth surface.

3.5 **ADJUSTING**

A. Make necessary adjustments of operating devices and equipment to ensure elevator operates smoothly and accurately.

B. Static balance car to equalize pressure of guide shoes on guide rails. Dynamically balance car and counterweight.

C. Lubricate all equipment in accordance with Contractor’s instructions.

D. Adjust motors, power conversion units, brakes, controllers, leveling switches, limit switches, stopping switches, door operators, interlocks, and safety devices to achieve specified performance levels.

3.6 CLEANING

A. Keep work areas orderly and free from debris during progress of project. Remove packaging materials on a daily basis.

B. Before final acceptance, remove protection from finished surfaces and clean and polish surfaces in accordance with manufacturer's recommendations for type of material and finish provided.

C. Remove all loose materials and filings resulting from work.

D. Clean equipment space equipment and floor.

E. Clean hoistways, Clean pit equipment and floor, car, car enclosure, entrances, operating and signal fixtures before final acceptance.

F. Stainless steel shall be cleaned with soap and water and dried with a non-abrasive surface; it shall not be cleaned with bleach-based cleansers.

3.7 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to operate elevators. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train Owner's

personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions.

B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.8 PROTECTION

A. Temporary Use: Comply with the following requirements for each elevator used for construction purposes:
   1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
   2. Provide strippable protective film on entrance and car doors and frames.
   3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
   4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
   5. Do not load elevators beyond their rated weight capacity.
   6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
   7. Engage Elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items which cannot be refinished in the field to the shop, make required repairs, and refinish entire unit, or provide new units as required.

END OF SECTION 142400

SECTION 200000 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED WORK

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems, tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 20, 21, 22 and 23 Contract Documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

F. Where Architectural features govern location of work, refer to architectural drawings.

G. Contractor may install additional piping, fittings and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

1.4 RELATED WORK

A. Utility Services:

1. Determine utility connection requirements and include in Base Bid all costs to Owner for utility service.

2. Include costs for temporary service, temporary routing of piping or any other requirements of a temporary nature associated with utility service.

B. Temporary Services:

1. Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:

1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before any work is started.
2. When interruption of services is required, Architect, Owner, and other concerned parties shall be notified and shall determine a time.

D. Demolition:

1. Division 02 - Selective Demolition.
2. Perform demolition as required to accomplish new work.
3. Accomplish work in neat workmanlike manner to minimize interference, annoyance or inconvenience such work might impose on Owner or other Contractors.
4. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
5. Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.
6. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
7. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other Contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such Work.

E. Concrete Work:

1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of mechanical equipment.

F. Painting:

1. Painting of mechanical equipment will be done under Division 09 unless specified otherwise or unless equipment is to be furnished with factory applied finish coats.
2. Equipment
   a. Furnish equipment with factory applied prime finish unless otherwise specified.
   b. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
3. Piping:
   a. Uninsulated Piping
      1). **[Paint cast iron, carbon steel, and copper piping located outside building.] [Paint cast iron, carbon steel, and copper piping located outside building and inside building within unfinished spaces without ceilings.] [Paint cast iron, carbon steel, and copper piping.]**
      2). **[Paint exposed fire protection piping.]**

3). **[Paint exposed natural gas piping.]**
4). Galvanized steel and stainless steel piping shall not be painted.

b. **[Insulated Piping]**
1). **[Paint exposed insulated piping located within unfinished spaces without ceilings.] [Paint exposed insulated piping.]**
2). Aluminum, stainless steel, PVC, and pre-colored insulation jackets shall not be painted.

c. Paint Colors
1). Fire Protection: [Red] [XXX]
2). Natural Gas: [Yellow] [XXX]
3). Domestic Water: [Green] [XXX]
4). Sanitary Waste and Vent: [Yellow] [XXX]
5). Storm and Overflow: [Green] [XXX]
6). Chilled Water: [Green] [XXX]
7). Heating Hot Water: [Yellow] [XXX]
8). Steam: **[Yellow] [XXX]**

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and Local Authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.6 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1. AGA .....American Gas Association
2. AMCA.....Air Movement and Control Association
3. ANSI .....American National Standards Institute
4. AHRI .....Air-Conditioning, Heating and Refrigeration Institute
5. ASHRAE .....American Society of Heating Refrigerating and Air Conditioning Engineers
6. ASPE .....American Society of Plumbing Engineers
7. ASSE .....American Society of Sanitary Engineering
8. AWS.....American Welding Society
9. AWWA .....American Water Works Association
10. ASME.....American Society of Mechanical Engineers
11. ASTM.....American Society for Testing and Materials
12. CDA .....Copper Development Association
13. CISPI .....Cast Iron Soil Pipe Institute
14. FMG.....FM Global
15. FS .....Federal Specifications
16. IEEE.....Institute of Electrical and Electronics Engineers
17. MCA.....Mechanical Contractors Association
18. MSS .....Manufacturers Standardization Society
19. NEC .....National Electrical Code
20. NEMA.....National Electrical Manufacturers Association
21. NFPA .....National Fire Protection Association
22. NIST.....National Institute of Standards & Technology
23. NSF.....National Sanitation Foundation
24. NSPI .....National Spa and Pool Institute
25. OSHA.....Occupational Safety and Health Administration

26. PDI.....Plumbing and Drainage Institute
27. SMACNA.....Sheet Metal and Air Conditioning Contractors National Association
28. UL .....Underwriters Laboratories, Inc.
29. WQA .....Water Quality Association

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.7 SUBMITTALS

A. Shop Drawings (Product Data):

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Divisions 20, 21, 22 or 23, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
3. Submit shop drawings for equipment and systems as requested in the respective specification sections. Submittals that are not requested may not be reviewed.
4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference numbers for each item. Clearly mark and note submittals accordingly.
7. Submit complete record of required components when fixtures, equipment and items specified include accessories, parts and additional items under one designation.
8. Include composite wiring diagrams for electrically powered equipment and devices.
9. Submit equipment room layouts drawn to scale, including equipment, piping, accessories and clearance for maintenance.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
12. Submittals that are not complete, not permanent or not properly checked by Contractor will be returned without review.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 - Operation and Maintenance Data.
2. Upon completion of Work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
4. Fire protection system shall be separately bound.

5. Manuals shall include the following:
   a. Copies of Shop Drawings
   b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
   c. CD ROM's of O&M data with exploded parts lists where available
   d. Phone numbers and addresses of local parts suppliers and service companies
   e. Internet/WEB page addresses where applicable
   f. Wiring diagrams
   g. Startup and shutdown procedures
   h. Composite electrical diagrams
   i. Flow diagrams
   j. Lubrication instructions
   k. Factory and field test records (Refer to Test and Balancing in Part 3 of this section.)
   l. Air and water balance reports
   m. Valve identification charts as specified in Section 20 0553 - Mechanical System Identification
   n. Access panel identification charts as specified in Section 20 0553 - Mechanical System Identification
   o. Additional information, diagrams or explanations as designated under respective equipment or systems specification sections.
6. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
7. Furnish O&M Manuals and instructions to Owner prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract, and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.8 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Electrical Coordination:

1. Refer to Section 20 0513 - Motors
2. Contractors for Divisions 20, 21, 22 and 23 shall provide the following items as specified under their respective Division(s) (Division 20, 21, 22 and 23):
   a. Motors
   b. Electrically powered equipment
   c. Electrically controlled equipment
   d. Starters, where specified
   e. Variable frequency drives, where specified
   f. Control devices, where specified
   g. Temperature Control wiring
   h. Wiring diagrams to Electrical Contractor for apparatus indicating external connection and internal controls.

i. Disconnect devices furnished with units (VFDs, chillers, prepackaged control devices, etc.)
   1). Devices shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings.
   2). Equipment electrical connection points shall be labeled with listed electrical short circuit current rating (SCCR). SCCR shall not be less than interrupting rating of upstream overcurrent device as shown on electrical drawings. SCCR shall be marked on equipment control enclosure in accordance with UL508, or other acceptable, accredited third-party testing agency standards.

3. Electrical Contractor will provide the following devices required for control of motors or electrical equipment, unless noted otherwise.
   a. Starters
   b. Disconnect devices
   c. Control devices:
      1). Pushbuttons
      2). Pilot lights
      3). Contacts
   d. Conduit, boxes and wiring for power wiring.
   e. Conduit, boxes and wiring for control wiring, except temperature control wiring.
4. Electrical Contractor will make connections, from power source to starter or variable frequency drive and from starter or variable frequency drive, where specified, to motor.
5. Where starters or other similar control devices are furnished by this contractor, they shall be installed by this contractor and wired by Electrical Contractor.
6. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, this contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this contractor.

C. Cutting and Patching:

1. Refer to General Conditions of the Contract, and Division 01 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:

1. Refer to Division 01 - Closeout Procedures.
2. As work progresses and/or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of Work, remove tools, scaffolding, broken and waste materials, etc., from site.

1.9 WARRANTY

A. Refer to Division 01 for general warranty requirements.

B. Refer to technical sections for warranty requirement for each system.

1. Where no warranty requirements are called out, warrant equipment, materials, and workmanship to be free from defect **[as called out in Division 01] [for 1 year after acceptance by Owner]**.

C. Warrant that systems will operate without objectionable noise, vibration and uncontrolled expansion.

D. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

E. In any case, wherein fulfilling requirements of any warranty, if this contractor disturbs any work warranted under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and warranty such restored work to same extent as it was warranted under such other contract.

F. Warranty shall include labor, materials, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer’s written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Protect openings in equipment until connected to system to prevent entry of foreign materials.

3.3 EXCAVATION AND BACKFILL

A. Refer to Division 31 - Earthwork.

B. Provide excavation and backfill for underground work unless otherwise indicated. Blasting is not allowed on this project without written permission of Architect and Owner.

C. Backfill trenches beneath concrete floor and stair slabs within building and beneath concrete slabs, walks, stairs and drives at exterior of building with gravel fill and compact to same density as surrounding area.

3.4 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc., with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required in interior floor slabs.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 20 0573 - Mechanical Systems Firestopping.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, all required openings, including those sleeved, formed or core drilled. Drawings shall be approved prior to preparing openings in structural member.

H. Provide minimum 1” clearance around penetration openings intended for pipe. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

I. Openings for underground pipes passing through foundations or under footings shall have minimum clearance of 1-1/2” to concrete. Do not disturb footing bearing soil.

J. Openings for underground pipe passing through on grade concrete slabs shall have minimum 1/4” clearance to concrete. Seal openings with urethane caulk.

K. Openings for insulated piping shall be sized based on outside diameter of insulation when it is specified or detailed to be continuous through opening.

L. Openings for duct penetrations shall be no more than 1/2” larger on all sides than size of duct or duct including duct insulation, if applicable. Where firestopping systems are required at penetrations, size in accordance with recommendations of firestopping systems manufacturer,

but opening shall not exceed 1” average clearance on all sides. Openings for ducts with fire dampers shall be in accordance with fire damper installation requirements.

M. Duct penetrations through concrete floors in mechanical rooms containing liquid heat exchangers and/or pumps shall have 2” high water stopped curbs surrounding openings. This applies to mechanical rooms above the lowest floor level.

N. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

O. Seal non fire-rated wall openings with urethane caulk.

P. Where penetrations occur through exterior walls into building spaces, use sleeves with integral water stop. For piping having outer surface temperature less than 150°F, use plastic (HDPE) sleeves, similar to PSI Link-Seal Model CS, rated to 150°F. For piping having outer surface temperature 150°F or higher, or where steel sleeves are shown or walls are fire rated, use steel sleeves with hot dip galvanizing, similar to PSI Link-Seal Model WS. Seal annular space between sleeves and pipe with Thunderline "Link-Seal" modular wall and casing seals, or sealing system by another manufacturer approved as equal by Engineer. Where "Link-Seals" are used with insulated pipe, insulation shall be butted against seals on both sides. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

Q. In lieu of openings as specified herein penetration systems as manufactured by Pro Set may be used, including sleeve couplings and plug.

R. If total Pro Set system with Water Guard “CR” is used, opening shall not need additional water proofing or riser clamps.

S. Finish and trim penetrations as shown on details and as specified.

T. Provide chrome or nickel plated escutcheons where piping passes through walls, floors or ceilings and is exposed in finished areas. Size escutcheons to fit pipe and pipe covering for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified.

U. Trim duct penetrations exposed in finished areas with 2” wide galvanized or aluminum trim collars properly sized to fit duct. Collars shall be same gauge as duct, prime finish unless noted otherwise. Finished areas shall not include mechanical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified.

V. In [GMP clean **room] [Bio-safety] [Animal holding] [Wash down]** areas,

1. Exposed conduit penetrations shall be sealed as follows:
   a. Escutcheons shall not be used when conduits are exposed in finished areas and penetrate finished surfaces.
   b. Cut and patch penetration to within 1/4” of conduit.
   c. Seal openings around conduit and patch work with [sealants specified in Division 07 – Joint Sealants.] [sprayable, flexible, liquid polyvinyl chloride coating equal to ANDEK "COCOON® 72634-USDA"]. Sealant shall be installed per manufacturer's application requirements.
   d. **[ANDEK Corp., 850 Glen Avenue, P.O. Box 392, Moorestown, New Jersey 05857-0392.]**
2. Penetrations other than conduits (junction boxes, light fixtures, etc.) including wiring devices shall be sealed as follows:

a. Seal non-rated opening with silicone sealant.
b. See Division 26 drawings for details.
c. Confirm selected sealant is compatible with paint provided by others prior to application.
d. Product: One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substances indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:
   1). 786 Mildew Resistant Silicone Sealant; Dow Corning Corp.
   2). Sanitary 1700 Silicone Sealant; General Electric Co.
   3). 898 Silicone Sanitary Sealant; Pecora Corp.
   4). Tremsil 600; Tremco Corp.
   5). OmniPlus; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

3.5 EQUIPMENT SHUTOFF VALVES

A. Provide shutoff valves at equipment connected to piping system. Refer to valve section or system section for requirements of valve type.

3.6 EQUIPMENT ACCESS

A. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for valves, shock stops or other equipment shall provide access for servicing, repairs, and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions.

E. Provide access doors in walls, chases or above inaccessible ceilings for valves, shock stops, unions or equipment/devices requiring access for servicing, repairs or maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire rated construction with UL Label. Provide steel, prime coated access doors unless otherwise specified. Provide stainless steel doors in ceramic tile walls, toilet rooms, locker rooms and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.

3.7 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

3.8 EQUIPMENT GUARDS

A. Provide equipment guards over belt driven assemblies, pump shafts, exposed fans, and elsewhere as indicated in this Specification or required by Code.

B. Paint equipment guards bright yellow.

C. Equipment guards shall comply with OSHA requirements.

3.9 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment and mechanical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rod or bolts at supporting elements as described above. Trim threaded rod or bolts such that they do not extend beyond supporting element and devices.

3.10 LEAD SHIELDING

A. Wherever installation of this Contractor's equipment destroys radiologic integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to restore that integrity. Coordinate these requirements with General Contractor.

3.11 MECHANICAL SYSTEMS IDENTIFICATION

A. Refer to Section 20 0553 - Mechanical Systems Identification

3.12 TEST AND BALANCING

A. Tests for equipment, ductwork and piping systems shall be performed as specified in their respective specification sections in accordance with technical requirements noted.

B. Provide equipment required for testing, including fittings for additional openings required for test apparatus.

C. All ductwork and piping inspections and testing shall be successfully completed and approved before application of covering materials.

D. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or material as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials. Caulking of holes or threaded joints is not allowed.

E. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria, test medium and pressure used, duration of test and name and title of person signing test certification document.

F. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

G. Balancing of various systems shall be in accordance with associated specification sections in addition to requirements noted herein.

H. If exterior domestic water supply also serves as source for fire protection systems, either exterior or interior or both, it shall be tested according to fire protection system requirements as specified in applicable Specification Section.

3.13 START-UP

A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and check-out of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.14 LUBRICATION

A. Upon completion of work and before turning over to Owner, clean and lubricate bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by manufacturer.

B. Contractor is responsible for maintaining lubrication of mechanical equipment under this Contract until Work is accepted by Owner.

3.15 CLEANING

A. Clean systems after installation is complete.

B. Clean piping and ductwork both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition.

C. Clean pipeline strainers to restore them to original condition or replace with new strainer elements.

D. Clean equipment and plumbing fixtures as recommended by manufacturers.

E. Replace throwaway or replaceable media air filters used during construction period with new filters or new filter media after construction has been completed and before building is turned over to Owner. Filter replacement shall be as hereinafter specified.

F. Blow and clean dirt, plaster dust and other foreign matter from coils, terminal devices, diffusers, registers and grilles.

G. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

H. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

END OF SECTION 200000

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SECTION 200513 - MOTORS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0514 - Variable Frequency Drive (VFD) System

B. Section 26 2913 - Enclosed Controllers

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer
2. hp, voltage, phase, hertz, rpm
3. Motor type
4. Enclosure type
5. Frame type
6. Insulation class
7. NEMA design designation
8. Service factor
9. Nominal efficiency at full load
10. Power factor at full load
11. Full load amperes
12. Bearings
13. Mountings
14. Dimensions
15. Weight
16. Shaft grounding brush for motors driven by Variable Frequency Drives (VFD)

1.4 PRODUCT CRITERIA

A. Motors covered by this Specification shall conform to applicable requirements of NEMA, IEEE, ANSI, and NEC Standards and shall be UL Listed where applicable for service specified.

B. Motors shall be designed for conditions in which they will be required to perform; i.e., general purpose, splash proof, explosion proof, standard duty, high torque or other special type as required by equipment manufacturers.

C. Select motors so they do not exceed nameplate rating nor operate into service factor to meet specified duty.

D. Motors located inside air handling units or exposed located in outdoor or wash down environments shall have totally enclosed fan cooled (TEFC) enclosures.

E. Motors shall be furnished for starting in accordance with utility requirements and be compatible with starters specified hereinafter or under Electrical sections of Specifications.

1. Refer to Section 26 2913 - Enclosed Controllers for reduced voltage starting requirements.
2. Starters for NEMA rated 200 or 230 V motors, 25 hp and above shall be reduced voltage starting type.
3. Starters for NEMA rated 460 V motors,60 hp and above to be reduced voltage starting type.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be new and guaranteed for service intended.

2.2 MOTORS

A. Voltage Ratings

1. Refer to equipment schedules and specification sections for voltages required.
2. Unless otherwise indicated, motors 1/3 hp and smaller shall be rated 115 V for operation on 120 V, 1 Ph, 60 Hz service.
3. Unless otherwise indicated, motors 1/2 hp and larger shall be rated:
   a. 460 V for operation on 480 V, 3 Ph, 60 Hz service.
   b. 200 V for operation on 208 V, 3 Ph, 60 Hz service.
   c. 230 V for operation on 240 V, 3 Ph, 60 Hz service.

B. Motors shall be 4 pole (approximately 1750 rpm) unless otherwise noted.

C. Single-phase motors shall be furnished with built-in thermal overload protection.

D. Use NEMA Design B motors, normal starting torque with regreasable ball bearings, and Class B insulation unless specified otherwise or unless manufacturer of equipment on which motor is being used has more stringent requirements.

1. Bearings shall be rated for minimum AFBMA 9, L-10 life of 26,280 hours (belted) and 200,000 hours (direct-coupled) at full-load.

E. Motors shall be rated continuous duty and have 1.15 service factor unless otherwise noted.

F. Motors Driven by Variable Frequency Drives (VFD)

1. Motors shall comply with the latest NEMA MG-1, Section IV, Part 31.
2. Motors shall have service factor not less than 1.0 at rated load.
3. Insulation shall be Class F or H.
4. Furnish each motor with shaft grounding ring utilizing conductive microfiber similar to AEGIS SGR to protect motor bearings from electrical damage.

G. Vibration shall not exceed 0.15” per second, unfiltered peak unless otherwise noted.

H. Motors (180 frames and larger) shall have provisions for lifting eyes or lugs capable of safety factor of 5.

I. Full load nominal efficiency of motors 1 hp and larger, except special-purpose motors including 2-speed or multi-speed motors, and rewound motors, shall meet or exceed listed values when tested in accordance with IEEE Standard 112 Method B as defined by NEMA Standard MG 1-12.6C. Efficiency values listed are based on NEMA Premium Efficiency Electric Motors of NEMA MG 1-2011, Table 12-12.

	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
hp	(6 pole)	(4 pole)	(2 pole)	(6 pole)	(4 pole)	(2 pole)
1 hp	82.5	85.5	77.0	82.5	85.5	77.0
1.5 hp	86.5	86.5	84.0	87.5	86.5	84.0
2 hp	87.5	86.5	85.5	88.5	86.5	85.5
3 hp	88.5	89.5	85.5	89.5	89.5	86.5
5 hp	89.5	89.5	86.5	89.5	89.5	88.5
7.5 hp	90.2	91.0	88.5	91.0	91.7	89.5
10 hp	91.7	91.7	89.5	91.0	91.7	90.2
15 hp	91.7	93.0	90.2	91.7	92.4	91.0
20 hp	92.4	93.0	91.0	91.7	93.0	91.0
25 hp	93.0	93.6	91.7	93.0	93.6	91.7
30 hp	93.6	94.1	91.7	93.0	93.6	91.7
40 hp	94.1	94.1	92.4	94.1	94.1	92.4
50 hp	94.1	94.5	93.0	94.1	94.5	93.0
60 hp	94.5	95.0	93.6	94.5	95.0	93.6
75 hp	94.5	95.0	93.6	94.5	95.4	93.6
100 hp	95.0	95.4	93.6	95.0	95.4	94.1
125 hp	95.0	95.4	94.1	95.0	95.4	95.0
150 hp	95.4	95.8	94.1	95.8	95.8	95.0
200 hp	95.4	95.8	95.0	95.8	96.2	95.4
250 hp	95.4	95.8	95.0	95.8	96.2	95.8

J. Single-phase motors for hard starting applications including outdoor applications shall be capacitor start type. Motors for fans and pumps located indoors may be split phase or permanent split-capacitor. Motors shall be equipped with permanently lubricated and sealed ball bearings and shall be selected for quiet operation. Motors 1/8 hp and below may be shaded pole type.

1. Refer to individual equipment section for additional requirements or specific type of motors.

K. 3 Ph, 2-speed motors shall be one winding, consequent pole, variable torque type and 1 Ph, 2-speed motors shall be capacitor start capacitor run type.

L. When submersible pumps are specified, each pump shall include in addition to controls specified, all necessary controls, relays, wiring, etc. that may be required for safety features incorporated in motor design. No submersible motor shall be run or activated until all requirements of motor manufacturer's recommendations have been complied with.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials in accordance with drawings, approved Shop Drawings and manufacturer's recommendations.

END OF SECTION 200513

SECTION 200514 - VARIABLE FREQUENCY DRIVE (VFD) SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

B. Section 23 0901 - Control Systems Integration

C. Section 23 2123 - Pumps

D. Section 23 3400 - Fans

E. Section 23 7313 - Air Handling Units

F. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

G. Section 26 2816 - Enclosed Switches and Circuit Breakers

H. Section 26 2913 - Enclosed Controllers

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SYSTEM DESCRIPTION

A. Provide Variable Frequency Drives (VFD) for each pump, fan or other driven equipment sized to accommodate motors shown on drawings or schedules. **[Provide all VFDs from same manufacturer.]**

B. **[VFD manufacturer shall review driven equipment and motors for VFD compatibility. Submit written statement from manufacturer of driven equipment along with VFD shop drawing submittals, indicating verification of compatibility.]**

C. VFD shall vary speed of its respective fan, pump or other driven equipment motor in response to either 4-20 mA or 0-10 VDC control signal provided by Control Contractor.

D. VFD system shall consist of the following:

1. Variable frequency drive(s)
2. UL Listed disconnect device
3. Electrical noise attenuation device**as specified in VFD schedule**

4. **[Motor starter for bypass mode operation with VFD/OFF/BYPASS selector and drive input and output isolation contactors where VFD bypass starters are scheduled**.]
5. Internal reactor with minimum 5% impedance or equivalent input line reactor
6. dV/dt Output filter as required to protect motor, based on total length of conductor from VFD to motor(s)

E. Drives shall have SCCR (short circuit current rating) of 65 KA.

1.4 QUALIFICATIONS

A. VFD system shall be furnished by a manufacturer with at least 10 yrs experience in design, construction and application of VFD.

1.5 SUBMITTALS

A. Shop Drawings for each VFD system including, but not limited to, the following:

1. Manufacturer's name
2. Identification of system components
3. Type of enclosure, front elevation and plan view, equipment weight, conduit access locations
4. Capacities/ratings/SCCR
5. Warranty
6. System wiring and block diagram showing system components
7. Performance, control and protection data with specified features clearly shown
8. Operating and monitoring devices with specified features clearly indicated
9. Start-up operation, maintenance, spare parts, and field tests
10. Manufacturer's installation instructions
11. Other appropriate data

B. After quality assurance tests are complete, submit written certification that drive and components have passed factory quality assurance tests.

C. Submit product and performance data on electrical noise attenuation device if required to meet electrical noise criteria specified. Isolation transformer is not electrical noise attenuation device.

D. Submit printed list of settings for all items that require setting during startup or list of Factory Default Parameters.

E. **[Submit calculations indicating conformance with electrical noise criteria specified. Refer to Electrical Documents for information regarding electrical building distribution system.]**

1.6 ELECTRICAL NOISE CRITERIA

A. Provide harmonic mitigation components as scheduled on drawings. Refer to VFD schedule and distance limitations in this specification for components required.

1.7 START-UP OPERATION AND MAINTENANCE DATA

A. Provide services of factory trained engineer or technician to approve installation; start-up test and adjust for proper operation; and instruct and train Owner's representative in operation and maintenance of VFD systems. Provide minimum of 4 h of Owner training for VFD system.

B. Should drive operation be deficient, make changes necessary to bring units into compliance with specified performance requirements. Cost of changes and retest shall be borne by drive manufacturer.

C. Upon completion of this service, submit report signed by manufacturer's service representative, including start-up and test log. **[Provide documentation of all setpoints and user adjustable parameters as configured for each drive.]**

D. Include additional 2 yr (total 3 yrs) warranty for VFD system, covering parts, labor and travel expenses.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers: ABB, Allen Bradley/Rockwell Automation, Emerson, Eaton, Danfoss, GE, Schneider Electric, Yaskawa, or Toshiba

2.2 FABRICATION

A. VFD shall be variable torque, solid state, microprocessor based control, modular design for standard induction AC motor.

B. VFD components shall be factory mounted and wired in NEMA **[1] [3R] [4] [4X] [12] [XXX]** enclosure with lockable door handle.

C. **[VFD components shall be factory mounted and wired in Plenum Rated Enclosure with lockable door handle.]**

D. Circuitry shall be plug-in, plug-out modular. Printed circuit boards shall have protective coating to reduce corrosion.

E. Unit shall conform to NEMA and NEC standards and be CSA, UL or ETL Listed. Control circuitry shall be electrically isolated from power circuitry. Entire assembly panel shall have UL or equivalent panel sticker.

F. Invertor section shall be pulse width modulated (PWM) design and most current insulated gate bipolar transistors (IGBTs) technology.

G. For motors 600 hp or larger, inverter section may be current source design.

2.3 PERFORMANCE REQUIREMENTS

A. Input: 460 (+10%, -15%) VAC, 3 Ph, 60 (± 2) Hz

B. Output: 460 VAC, 3 Ph, 10 to 60 Hz

C. Operating Environment Conditions: Ambient -10° to 40°C temperature, relative humidity up to 95% non-condensing.

D. Linear acceleration and deceleration adjustable from 5 to 60 seconds. Provide adjustable v/Hz ratio and low speed boost features.

E. Output Current Rating: Continuous full load output current rating of drive shall not be less than that listed for motor of equivalent horsepower in NEC table 430-150.

F. Drive overload capacity to be minimum 110% of motor FLA based on NEC ratings for one minute.

G. Time to Shutdown: Inversely proportional to square of overload current ($t = k/I^2$).

H. Motor Regeneration Protection: Unit shall have capacity of dissipating regeneration energy up to VFD current rating without damage to or shutdown of drive. Unit shall be capable of starting into rotating load.

I. Output Frequency Stability: ± 0.5% of base frequency in 24 h throughout range of rated operating conditions.

J. Output Voltage Regulation: ± 2% of maximum rated output voltage.

K. Output voltage rise time shall be no faster than 1000 V/micro sec measured at the motor terminals. If power and control cable between VFD and motor is more than 100 ft, provide dv/dt output filter.

L. Power Loss Ride-Through: 1 cycle.

M. Linearity (speed reference to output frequency): ±1.0%

N. Input Power Factor: Minimum of 0.95 regardless of speed and load.

O. Minimum drive efficiency as percent of input power shall be as follows:

Percent Load	Frequency (Hz)			
	60	50	30	15
100	97	96	95	90

2.4 CONTROL FEATURES

A. VFD speed control circuit shall accept either 4-20 mA DC or 0-10 VDC isolated ungrounded transmitter signal in automatic mode and from manual speed control keypad in manual mode.

B. Provide adjustable minimum and maximum speed settings (0 - 100%) for both auto and manual mode. Initial minimum setting shall be 25%.

C. Provide adjustable automatic reset for fault trips, except short circuit type faults. After selected number of unsuccessful restart attempts, drive shall be shut down. Number of restart attempts and time interval between resets shall be selective.

D. When unit shuts down due to power outage, unit shall be capable of being restarted manually or automatically.

E. VFD shall be capable of starting into rotating loads spinning in any direction.

F. Provide critical frequency avoidance circuit with at least 3 field adjustable bands to avoid operation at speeds, which cause excessive vibration in driven equipment.

G. Provide isolated ungrounded output signal to indicate drive percent of speed or drive frequency.

H. **[Provide control for automatically switching from VFD to by-pass line through adjustable time delay relay or equivalent protection whenever VFD shuts down automatically.]**

2.5 COORDINATION WITH BUILDING AUTOMATION SYSTEM (BAS)

A. Furnish each VFD with digital communication bus card for BAS use. Coordinate with Control Contractor for specific interface requirement.

B. Provide contacts (1 NO and 1 NC contact) for remote input control of start/stop function for VFD mode.

C. Provide three programmable relay/contacts (1 NO and 1 NC contact each) for remote output indication of VFD fault condition. VFD status, and bypass mode if bypass is specified.

2.6 PROTECTION FEATURES

A. Power circuits shall be protected by electronic protection circuits. Electronic protection circuits shall provide orderly shutdown without blowing fuses and prevent component loss under the following abnormal conditions.

1. Instantaneous overcurrent and over voltage trip of output
2. Solid state protective circuit shall provide NEC motor running overload protection tested in accordance with UL Standard 991
3. Power line overvoltage or undervoltage
4. Phase sequence detection or insensitivity to incoming power phase sequence
5. Single and 3 Ph short circuit protection
6. Control circuit malfunction
7. Overtemperature
8. Ground fault for all 3 phases

B. VFD shall protect itself from damage due to phase-to-phase or phase-to-ground faults without fuse blowing or use of isolation transformers. VFDs which require isolation transformers to provide ground fault protection are not acceptable.

C. In addition, provide the following protection features.

1. Input line-to-line and line-to-ground transient protection up to 3000 V

2. Control circuit transformer fusing
3. Grounded control chassis
4. Diagnostic indication
5. One set of three (3) spare fuses for each size or type of VFD

D. VFD shall employ adjustable torque limit control, which shall override speed command and decrease frequency while maintaining correct volts/hertz ratio whenever load level surpasses VFD design level or set point.

2.7 OPERATING AND MONITORING DEVICES

A. The following functionality shall be provided and may be controlled via touchscreen/keypad:

1. Door interlock to disconnect VFD input power
2. Hand-Off-Auto device
3. Operating mode selector device marked "Hand-Off-Auto"
4. Manual speed control keypad
5. Power on indication
6. Drive run indication
7. Drive fault indication with testable feature
8. Fault reset device

B. Speed indicating meter or digital indication (0 - 100%) calibrated in percent speed or frequency meter with 0 to 90 Hz scale to indicate motor speed.

C. Integral digital programming and operating display which shows Hz, Percent Output Current, Output Voltage, Percent Output Power, Operating Parameters and their values, and Diagnostic Fault Codes. In addition, Keypads shall be incorporated to facilitate digital programming of drive adjustments. Analog potentiometer adjustments are not acceptable.

D. Provision shall be included to provide selectable programming security by inhibiting program parameter changes with password security.

E. Control shall incorporate microprocessors for operator interface, diagnostics, and fault managements, and power management.

F. Optional programming software, which includes provision for serial communication with drive, shall be available for shipment at time of equipment order placement.

G. Fault buffers to sequentially store last 4 faults. Parameter and fault information to be stored in non-volatile memory.

H. **[VFD with Manual Bypass Starter:**

1. **Manual selector switch to select power through VFD or bypass line with label marked "VFD/OFF/BYPASS".**
2. **Electrically-interlocked VFD/BYPASS contactors with padlocking capability on input side of VFD and bypass starter. Interlock shall be accomplished such that shorting together of any 2 control circuit points cannot cause non-selected device to be energized. Provide electrically-interlocked device that connects only output of selected starting device (VFD or bypass starter) to VFD system output lug. Single**

shorting of any 2 control circuit points shall not cause both VFD and bypass starter outputs to be interconnected.

I. **Redundant VFDs:**

1. **Manual selector switch to select power through VFD1 or VFD2 with label marked "VFD1/AUTO/VFD2".**
2. **Electrically-interlocked VFD1/VFD2 contactors with padlocking capability on input side of VFDs. Interlock shall be accomplished such that shorting together of any 2 control circuit points cannot cause non-selected device to be energized. Provide electrically-interlocked device that connects only output of selected starting device to system output lug. Single shorting of any 2 control circuit points shall not cause both VFD outputs to be interconnected.**

2.8 QUALITY ASSURANCE TESTS

A. Complete drive assembly shall be factory tested with actual AC induction motor, 100% load and temperature cycled within environment chamber at 104°F. Documentation of test shall be furnished to verify successful completion of test at Engineer's request.

2.9 DISCONNECT DEVICE

A. Provide integral switch to disconnect incoming electrical power to units. Disconnect device shall be UL Listed devices:

1. Enclosed molded case breaker; ampere rated and providing over current protection
2. Fused switch may be used as option. Fused switch shall be ampere rated and provide overcurrent protection. Non-time delay fuses shall be sized for connected drive and motor.

B. Disconnect device shall be capable of being padlocked in OFF position and complying with OSHA Requirements. Operating handle shall indicate whether switch is “ON” or “OFF”.

C. Switch shall have cover interlock to prevent unauthorized opening of switch door when handle is in “ON” position and to prevent closing of switch mechanism with door open. Provide defeater mechanism to defeat the interlock for user required access.

2.10 [MOTOR CONTROL EQUIPMENT (BYPASS STARTERS)

A. **Bypass starter shall be NEMA or IEC Rated device of the following:**

1. **Electromechanical across-the-line starter with solid state overload protection for** 50 hp **or smaller.**
2. **Solid-state reduced voltage starter consisting of SCR based power section, logic control board and solid state overload protection for** 60 hp **or larger.**
3. **[Reduced voltage auto transformer - electromechanical starter with solid-state overload protection for** 60 hp **or larger.]**
4. **Bypass shall include high speed fuses for VFD (not in bypass circuit).**
5. **Service switch to disconnect power to VFD (not in bypass circuit).]**

2.11 VFD BYPASS EQUIPMENT (DUTY/STANDBY DRIVES)

A. Provide redundant drive bypass where scheduled. Drive assembly shall include two individual VFDs of the scheduled capacity, mounted inside one common enclosure, fully pre-wired and ready for installation as a single Listed device.

B. VFD Bypass equipment shall include the following:

1. All harmonic mitigation, control features, protection features, operation and monitoring devices and disconnecting means shall be provided independent of the bypass drive.
2. Provide input and output contactors to disconnect the non-operational drive. Either VFD shall be fully serviceable when not operating, without interrupting operation of functional drive.
3. Automatic transfer to bypass based on primary drive fault with manual switch to select automatic or manual changeover from faulted drive to redundant drive.
4. Remote transfer to bypass functionality.
5. Manual selector switch to select VFD A or VFD B operation.
6. Manual selector switch to allow testing, adjustment and programming of either VFD A or VFD B while the alternate VFD is operating.
7. Indication lights to annunciate VFD A Fault, VFD B Fault, VFD A Run, VFD B Run
8. Bypass shall include high speed fuses for input protection of each VFD.

C. Primary/Redundant drive assembly shall be provided with one point of electrical connection for input conductors, and multiple points of electrical connection for output conductors to motors. Where multiple motors are served from a single redundant drive assembly, provide individual motor overload protection for each motor [integral to drive enclosure] [in separate enclosure.

2.12 INPUT LINE REACTORS

A. Series line reactors shall be designed for harmonic filtering service and shall be UL component recognized. Construction shall be copper wire wound on steel cores. Inductors shall be 3-phase. Series line reactors shall be sized per harmonic analysis and appropriately for total connected load. Design maximum temperature rise for inductors shall be 115°C.

B. Inductors shall be air-gapped to avoid saturation. Inductance shall be measured under full load and shall be within ±5% of design value.

C. Line reactor shall be included integral to drive enclosure.

1. Where mounting line reactor in VFD enclosure is not possible, enclosure shall be steel with enamel finish and no knockouts. Enclosure shall match construction of VFD enclosure and shall have hinged lockable cover. Screened openings shall be provided for enclosure ventilation. Enclosure shall be built with integral mounting brackets for platform or wall mounting. Coordinate location with other trades. Provide disconnect switch for line side filters.

D. Internal DC bus chokes are acceptable when providing equivalent performance to AC line reactors specified.

2.13 ACTIVE FRONT END FILTER

A. Active front end filter shall supply non-linear loads with near sinusoidal current waveform. Filter shall be rated for application at maximum fundamental system frequency of 60 Hz and nominal system voltages up to 600 V.

B. Unit shall include input protection with minimum kAIC rating to match upstream electrical distribution equipment. Current limiting protection shall also be provided.

C. Unit shall have ability to communicate via protocol to match Building Automation System.

D. Multiple units may be installed in parallel as necessary to meet load requirements. Failure of single unit shall not impact other units in parallel.

E. Unit shall have field configurable relay based fault output.

2.14 DV/DT OUTPUT FILTER

A. dV/dt motor-protecting output filter shall be a low-pass filter consisting of a gapped, three phase iron core inductor, AC-rated capacitor and wire-wound resistors.

B. The filter shall be rated for application at a maximum fundamental system frequency of 60 Hz at nominal system voltages up to 600V.

C. Ambient temperature of operation shall be 104°F.

D. The combined inductance, capacitance and resistance of the Output Filter shall be specifically designed to reduce voltage waveform dV/dt.

2.15 SPARE PARTS

A. Additional enclosure cooling fan for each different type of drive.

B. Additional key pad/touch screen for each different type of drive.

PART 3 - EXECUTION

3.1 INSPECTION

A. Visually inspect equipment and components at time of delivery. Submit report to Engineer with list of items or deficiencies to be corrected.

3.2 PROTECTION

A. Protect VFD cabinets from dust/dirt during storage and operation until turned over to Owner.

B. If VFDs are not furnished with internal air filter racks, provide temporary filter media to protect VFD cabinets and replace filter media as required.

3.3 INSTALLATION

A. Install VFD system in accordance with details, approved Shop Drawings and manufacturer's instructions and recommendations.

B. Provide field low voltage wiring of VFD system components. Provide field interconnecting wiring between VFD and filters, line reactors and/or by-pass starter if bypass starter is specified and the wiring is not installed at factory. Install wiring in metal conduit and in accordance with Electrical sections of this Specification and applicable Electrical Code.

C. Provide output dV/dt filter for motor protection where the total conductor length between drive output and motor terminal(s) exceeds 50 feet.

D. Provide control wiring between interlocks in VFD control circuits and driven motor's disconnect switches. Interlock VFD control circuits with driven motor's disconnect switches where such motor disconnect switches are provided. Disconnecting on-line motor shall shut down VFD. VFD shall restart upon reconnection of motor.

E. Do not connect ground from one unit to another unit's cabinet.

F. Use separate conduits for incoming and outgoing power conductors from each unit.

G. Use separate conduit for control wiring for each unit. Do not combine control wiring with power wiring.

H. Use minimum 18 ga shielded wiring with ground for control wiring.

I. Unless otherwise indicated, mount VFD so that display and keypad are at approximately 5’-0” to 5’-6” above floor.

J. Install floor mounted drives on 3-1/2” high concrete housekeeping pad.

3.4 START UP

A. VFD manufacturer shall perform field inspection, start-up and testing of VFD in accordance with procedures as defined by manufacturer for proper operation.

B. Adjust critical frequency avoidance feature to step over frequencies which cause excessive vibration in driven equipment.

END OF SECTION 200514

SECTION 200520 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section lists methods and materials for trench excavation and backfill for plumbing piping systems inside and outside the building.

B. Refer to **XXX** report, available from Construction Manager for data on soil conditions.

1.2 RELATED WORK

A. Division 31 - Earthwork

1.3 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions of Contract, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.4 SUBMITTALS

A. List of materials to be used for backfill.

PART 2 - PRODUCTS

2.1 FILL MATERIAL

A. Type 1 Fill:

1. Material from excavation separated from materials, which do not compact by tamping and rolling. No stones larger than 3” and no building, organic, corrosive or frozen materials.

B. Type 2A Fill:

1. Sand or gravel materials with none larger than 2” and of that portion passing #4 sieve less 5% to pass #200 sieve.

C. Type 2B Fill:

1. Sand or gravel materials with none larger than 1/2” and of that portion passing #4 sieve less 5% to pass #200 sieve.

D. Type 3 Fill:

1. Gravel of rounded to subangular shape, screened, which will pass 0.75” sieve and retained on #4 sieve.

E. Type 4 Fill:

1. Pit run rock or gravel with maximum stone size of 1”.

F. Type 5 Fill:

1. Pea gravel, screened, which will pass 0.375” sieve and retained on #4 sieve.

G. Type 6 Fill:

1. Soils Engineer approved fill material, backfilled and compacted beneath building footprint.

PART 3 - EXECUTION

3.1 PREPARATION

A. Establish grade lines and locations of mains and manholes. Provide necessary stakes and batter boards.

B. Verify invert elevations of existing utilities prior to excavation for new utility piping.

3.2 EXCAVATION

A. Provide excavation for all underground work, including piping, manholes, catch basins, tanks, concrete structures, etc., unless otherwise shown or specified. Lay piping in open trench except when Architect gives written permission for tunneling.

B. Include all necessary clearing; tree removal; grubbing; pavement removal; substructure removal such as walls, footings and piers and all incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing and transportation. Coordinate excavation extending beyond construction limits with Construction Manager and Owner.

C. Blasting is not allowed on this project without written permission of Architect and Owner.

D. **[Remove all excess excavation material from site unless directed otherwise] [Dispose of excess excavation material on site in location designated by Construction Manager]**.

E. Use mechanical methods to remove rock in trenches for piping systems.

F. Include rock excavation in the Bid unless otherwise indicated.

3.3 PIPE INSTALLATION

A. Keep underground piping to proper line and grade and sealed at all times to prevent entrance of animals or foreign matter.

B. Provide bracing and sheet piling as necessary to support trenches. Comply with Local Regulations, applicable provisions of OSHA Regulations on trenching, or with provisions of “Manual of Accident Prevention in Construction” published by Associated General Contractors of America.

C. Under no circumstances lay pipe or install appurtenances in water. Keep trench free from water until pipe joint material has hardened.

D. Presence of ground water in soil or necessity of sheet piling or bracing trenches shall not constitute condition for which any increase may be made in Contract price, except when sheet piling is left in place on written order of Owner, Contract price will be adjusted.

E. Cut off sheet piling left in place not less than 2” below new finished grade. Do not remove sheet piling until trench is substantially backfilled.

F. **[Install underground plastic pipe per ASTM D2321.]**

G. Place underground piping outside and inside building in open excavated trenches. Where trench bottom does not contain stones larger than 1” in size or where bedrock is not encountered, trench may be excavated to final pipe grade. Where bedrock or stones larger than 1” is encountered, excavate entire length of trench to depth 4” below final pipe grade elevation and provide 4” of pipe bedding material compacted to minimum of 90% Standard Proctor Density consisting of Type 2B, 3 or 5 fill to establish final pipe grade. Shape bedding for clearance for all joints and fittings, tamped in place and graded evenly to insure uniform bearing for full length of pipe. Do not support piping by blocking, planking or mounding of bedding material.

3.4 BACKFILL

A. Exterior:

1. Backfill outside building including all piping beyond construction limits only after piping and appurtenances have been inspected, recorded, tested and approved. Backfill around pipe by hand to depth of 12” above top of pipe with Type 2B, 3 or 5 fill in 6” layers. Take care not to disturb pipe or damage pipe coating. Do not use Type 3 fill where it will come in contact with polyethylene encasement specified in Section 21 1114 - Exterior Fire Suppression Piping Systems and Section 22 1114 - Exterior Services. Compact backfill thoroughly with compactor of suitable weight or with approved mechanical tamper. No flooding or jetting with water is allowed.
2. Place backfill from 12” above pipe in layers not exceeding 8” in depth with Type 1 fill. Compact backfill material to the same density as surrounding area prior to that of excavation.
3. When excavating through areas which are to become walks, roads, driveways or parking areas of concrete, bituminous or exposed gravel surfacing or such areas are existing to remain; backfilling from 12” above pipe to subgrade shall be with Type 2A, 2B, 3 or 4 fill. Backfill in 12” layers and compact with mechanical means to density 95% modified proctor. Frequency of compaction testing shall be determined by testing consultant, based on site conditions, materials and workmanship.
4. When excavation occurs on public property or areas beyond property line, all excavation, pipe laying, backfilling, grading and surfacing shall conform as herein specified, except additional requirements for public utility or other authorities shall be complied with when in order. Check with each utility and incorporate cost of any additional requirements in Base Bid.

B. Interior:

1. Backfill inside building only after piping and appurtenances have been inspected and approved. Backfill to 12” above pipe with Type 2B, 3 or 5 fill in 6” layers. Remainder of backfill shall be Type 2A, 2B, 3, 4, or 6 fill in 12” layers.
2. Install lines passing under foundations with minimum of 1-1/2” clearance to concrete and insure there is no disturbance of bearing soil.
3. Backfill piping suspended from slab on grade with Type 2B or 5 fill in 6” layers. Same fill materials shall be provided for 12” minimum on each side of pipe.

3.5 ROCK EXCAVATION

A. Consider material over one cubic yard in size encountered during excavation as rock. Rock excavation will be paid as extra if it cannot be removed by 200 net hp crawler tractor with ripper attachment all in good running condition and operated by an experienced individual.

B. Excavate rock to 4” below intended pipe invert.

3.6 FINISHING

A. On completion of trenching and backfilling operations, restore grades to original elevation or to new subgrade elevation.

B. When trenching is through existing areas or beyond constructions limits, replace surfaces to existing conditions.

C. In landscaped areas use 6” of topsoil and sod to match existing elevations, or as otherwise approved by Landscape Architect.

END OF SECTION 200520

SECTION 200529 - PIPING AND EQUIPMENT SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0549 - Seismic Anchorage and Restraints

B. Section 20 0700 - Mechanical Systems Insulation

C. Section 23 0550 - Vibration Isolation (Spring Hangers and Mounts)

D. Section 23 3114 - Ductwork (for duct supports requirements)

1.2 [REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]**

1.3 DESCRIPTION

A. Provide all supporting devices as specified and as required for proper support of piping, ductwork, equipment, materials and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.

C. Support of fire protection pipe shall comply with NFPA 13 Standard for the Installation of Sprinkler Systems, **[2013] [XXX]** Edition.

1.4 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:

1. Manufacturer's name
2. Model numbers
3. Materials of construction and load ratings (lbs)
4. Schedule of hangers and support devices with pipe support spacing
5. Insulated pipe supports along with application chart or table
6. Insulation protection saddles and weight bearing insulation table
7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
8. Structural attachments, inserts and concrete anchors. Submit ICC-ES Evaluation Report for each type of anchor.

9. Calculations and drawings for concrete inserts and anchors for each application
10. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
11. Drawings showing specific locations of any suspended loads which exceed 100 lbs within joist chord panel to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)
12. Equipment mounting devices
13. Pipe guides and anchors
14. All other appropriate data

1.5 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME B31 Code for Pressure Piping and MSS Standard Practice SP-58-2009 (Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Support devices shall have published load ratings.

D. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

E. Determine maximum deflection using the following equation.

$$D = \frac{H \text{ or } L}{250}$$

Where D = Max deflection in inches
H = Member height in inches
L = Member length in inches

F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.

1. Corrosive atmospheres include the following locations:
   a. Exterior locations
   b. Chemical storage and hazardous waste storage rooms
   c. Food service/kitchen areas
   d. Locker/shower rooms
   e. Meter pits
   f. Utility tunnels
   g. Cage wash room (dirty and clean)
   h. Sterilizer/autoclave room

G. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.

H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.

I. This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 20 0700 - Mechanical Systems Insulation.

J. In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports for distance of 100 pipe diameters or 50 ft away from equipment, whichever is greater.

K. Piping connected to coils, which are in assembly mounted on vibration isolators, shall have vibration isolation hangers or supports as indicated above. Piping connected to coils, which are in equipment where fan assembly is separately isolated by vibration isolators and flexible connections, does not require additional vibration isolation hangers or supports. Refer to Section 23 0550 - Vibration Isolation for flexible connections, vibration isolators and additional requirements.

L. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

M. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

N. Unless otherwise indicated, continuous insert channels are not allowed.

O. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

P. Refer to Structural Documents and ICC-ES Evaluation Report for application of concrete inserts and concrete anchors.

Q. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of open web steel joists.

R. Coordinate with General Contractor for any proposed weld attachments to building structure. This may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

S. Top or bottom chords of open web steel joists may be used to support loads, provided total load within panel does not exceed 100 lbs and load is placed concentric to joist. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord).

T. Where fire rated fiberglass products are used for channel and support devices, the following properties shall apply:

1. Flame Spread Properties
   a. Polyester Fiberglass (PF) Class 1 ASTM E-84
   b. Vinylester Fiberglass (VF) Class 1 ASTM E-84

U. Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

PART 2 - PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Design and provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, connections, etc. to suspend or floor support equipment.

B. Supporting steel in **[clean rooms] [XXX]** shall be stainless steel.

2.2 PIPE HANGERS AND SUPPORTS (METALLIC)

A. Manufacturers: Anvil, Erico, Tolco, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS Type is indicated where applicable.

B. Hangers/supports for copper pipe where supports directly contact to pipe shall be either plastic, vinyl or epoxy coated.

C. For insulated pipe supports, refer to Insulated Pipe Supports in Part 3 of this Section.

D. Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (120°F and above)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” to 6”	---	171 (MSS Type-41), 181 (MSS Type-43)
	8” and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (60°F to 119°F)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” and larger	260 (MSS Type-1), 216 (MSS Type-4)	---
Cold Pipes with Insulation (33°F to 59°F)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” and larger	260 (MSS Type-1), 295 (MSS Type-1)	---
Cold Pipes with Insulation	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---

(32°F and below)	2-1/2” to 6”	260 (MSS Type-1)	171 (MSS Type-41), 181 (MSS Type-43)
	8” and larger		171 (MSS Type-41)

1. For pipe size 2-1/2” and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4°.

E. Flat Surfaces (Trapeze, Rack Type):

1. Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (120°F and above)	2” and smaller	243, 244	---	---
	2-1/2” and larger	---	171 or 177(MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60°F to 119°F)	6” and smaller	B-Line BVT	---	---
	8” and larger	137 (MSS Type-24)		
Ambient Bare (Copper) pipes (60°F to 119°F)	all sizes	B-Line BVT		
Cold Pipes with Insulation (33°F to 59°F)	10” and smaller	137 (MSS Type-24)	---	---
	12” and larger	432	---	---
	2” and smaller	243, 244	---	---

Cold Pipes with Insulation (32°F and below)	2-1/2" and larger	---	171 or 177 (MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.

F. Vertical Pipe within Wall Cavities

1. Use clamps, straps, inserts or channels to support pipes concealed in wall cavity. Select members for pipe support types and loading conditions. Refer to Part 1 for design criteria.
2. Provide clamps, strut channels, insulated supports, or brackets and inserts equal to manufacturer indicated below:

System	Pipe Size	Supports	Clamps, Brackets/Inserts	Pre-insulated Inserts
Hot and Cold Pipes with Insulation	All sizes	Anvil 137	HoldRite 260 series with SBIS bracket, Anvil 262	Anvil Klo-Sure, Pipe Shields A2000
Ambient Bare Steel Pipes (60° to 119°F)	All sizes	Anvil 137, 138-R	Anvil 262	---
Ambient Bare Copper Pipes	All sizes	Anvil CT-138R	HoldRite 260 series with SBIS bracket	---

2.3 PIPE HANGERS AND SUPPORTS (NON-METALLIC)

A. Manufacturers: Aickinstrut, B-Line, Strut-Tech, Unistrut, Litchfield International, equal to B-Line figures listed

B. Clevis Type Hangers:

System	Pipe Size	Clevis
[XXX]	4" and smaller	B-Line No. BFP22 SH series
[XXX]	**[XXX]**" and smaller	B-Line No. BFP22 SH series
Uninsulated Pipe	4" and smaller	B-Line No. BFP22 SH series

C. Clamp Type Hangers:

System	Pipe Size	Clamp	Cushions
Iron Pipe	**[XXX]**" and smaller	B-Line No. BFP-2000 Series	--
Steel Pipe	**[XXX]**" and smaller	B-Line No. BFP-2000 Series	--
Copper Tubing	**[XXX]**" and smaller	B-Line No. BFP-2000 Series	--

2.4 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi, shall be as follows:

Pipe Size	Length	Gauge
1/4” thru 3”	12”	18
4”	12”	16
5” and 6”	18”	16
8” thru 14”	24”	14
16” thru 24”	24”	12

2.5 INSULATION PROTECTION SADDLES

A. Anvil Fig. 160 Series (MSS Type-39) constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified in Section 20 0700 - Mechanical Systems Insulation.

2.6 WEIGHT BEARING INSULATION INSERTS

A. Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.

B. Minimum length of inserts shall be 12”, or 2” longer than insulation protection shields, whichever is longer. Compressive strength and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.

C. Hot Pipes (120°F and above):

1. High-density calcium silicate insulation (Type H) similar to Johns Manville Thermo-12 or cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas. Maximum compression strength for load calculation shall be 90 psi.

D. Cold Pipes (59°F and below):

1. Cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas, maximum compressive strength 90 psi, rigid closed cell insulation (Type PP) similar to Trymer Green by ITW, maximum compressive strength for load calculation 31 psi, or expanded polyisocyanurate insulation (Type P) similar to Trymer 2000XP by ITW, maximum compressive strength for load calculation 24 psi.
2. SNAPP ITZ pre-insulated pipe supports by Mechanical Pipe Shields Mfg or Tru-Balance Insulated Saddles by Buckaroos, Inc. may be used. Pre-insulated pipe supports shall use polyisocyanurate (Trymer 2000 or 4000 or Insul-Phen insulation), with 360° PVC jacket up to 3” and 180 or 360 degree G90 galvanized steel shield.

2.7 PRE-INSULATED PIPE SUPPORTS

A. Pipe Shields, Inc., Bergen Pre-Insulated Pipe Supports, Rilco, or Tri-State Industries equal to Pipe Shields models listed

B. Insulation shall consist of water-resistant calcium silicate of same thickness as adjoining pipe insulation, thermal conductivity not more than 0.38 Btu·in/(hr·ft^2·°F) at 75°F mean temperature, minimum density of 13 lb/ft^3, and compressive strength not less than 100 psi.

C. Structural inserts shall be water-resistant, high-density calcium silicate with minimum density of 32 lb/ft^3 and minimum compressive strength of 600 psi. Structural inserts shall be used as recommended by manufacturer to meet load ratings.

D. Use vapor barrier steel jacket around insulation. Insulation jackets shall be galvanized steel conforming to ASTM A-527. Hanger bearing surface shall consist of galvanized sheet metal insulation protection shield or casing.

E. When recommended by manufacturer, use double layer insulation protection shield at support bearing surface. Insulation shall extend 1” beyond insulation protection shield to maintain vapor barrier integrity.

F. Pre-insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes and standards: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

G. Load tests shall be made on both supporting materials and configurations. All tests shall be performed by independent testing laboratory. Results of pertinent tests shall be available upon request.

H. Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Shaw Pipe Shields, Inc.

1. Pipe supported on hangers: Models A2000, A4000, A9000, D3000 and D3200
2. Pipe supported on flat surfaces: Models A2000, A4000, A6000, A7000, A7200, and A7400
3. Pipe supported on pipe rolls: Models A4000, A6000, A8000, A8200, and A8400
4. Pipe supported on slides: Model "B" Series
5. A1000, A3000 or A5000 may be used for hot pipes (120°F and above)

I. Select proper model to conform to pipe service, support style, and support spacing.

J. Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

K. Pipe support spacing shall be in accordance with manufacturer's recommendations, but in no case shall exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

2.8 HANGER RODS (METALLIC)

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size With Single Rigid Rod	Rod Diameter (inches)	Max Load (lbs) of Hanger Rod (Not exceeding 650°F Service Temp.)
2”	3/8	730
3”	1/2	1350
5”	5/8	2160
8”	3/4	3230
12”	7/8	4480
18”	1	5900
30”	1-1/4	9500

D. Threaded rods are not allowed in clean rooms.

2.9 HANGER RODS (NON-METALLIC)

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule.

C. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size With Single Rod	Rod Diameter (inches)	Max Load (lbs) of Hanger Rod (Not exceeding 200°F Service Temp.)
[XXX]	**[XXX]**	**[XXX]**

2.10 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish

2.11 ROD ATTACHMENTS

A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.12 U-BOLTS

A. Anvil Fig. 137 (MSS Type-24), galvanized finish

2.13 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 133/134 (MSS Type-21), 218 (MSS Type-30), 228 (MSS Type-28 or 29) and 292 (MSS Type-28 or 29)

B. Top Beam Clamps: Anvil Fig. 227 (MSS Type-25)

C. C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-19 or 23) with set screw and lock nut

2.14 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.15 RISER CLAMPS

A. Anvil Fig. 261 (MSS Type-8), galvanized finish

B. B-Line B3373C, PVC coated carbon steel, in area at pipe contact, for bare copper tubing

C. Proset system, proseal plug and fire-fill for sleeved and cored holes.

2.16 CONCRETE INSERTS (WOODEN FORMED CONCRETE)

A. Anvil Fig. 281 or 282, or Hilti HCI-WF (MSS Type-18), suitable for rod diameter and weight supported.

2.17 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Anvil Fig. 284, Tolco No. 109 A, B-Line Fig. B3019, Powers Fasteners "Bang-It", Hilti HCI-MD, or MSCO No. MX34.

2.18 CONCRETE ANCHORS

A. Manufacturers: Hilti, Powers Fasteners or Red Head

B. Anchors shall be selected, sized, and detailed by Contractor’s structural engineer registered in project’s jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.

C. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

F. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 20 0549 – Seismic Anchorage and Restraints and Structural drawings.

G. Anchors shall be zinc plated in accordance with ASTM B633.

H. Select anchors with load ratings based on cracked concrete conditions.

2.19 CONTINUOUS INSERT CHANNELS

A. Manufacturers: Unistrut, Anvil, B-Line, Michigan, Halfen, Hilti or Kindorf. Brackets inserts and accessories shall be suitable for channel insert selected.

B. Length and support capabilities to be suitable for supporting plumbing piping in vicinity.

2.20 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 ga.

2.21 PIPE MOUNTING PEDESTALS

A. Equal to Roof Products & System Corporation consisting of equipment rail, "U" shaped mounting brackets, galvanized threaded rod and cast iron pipe rollers. Rail shall have built-in raised cant to match roof deck insulation.

2.22 EQUIPMENT RAILS

A. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc. or Vent Products equal to Roof Products & Systems Model ER-4 with raised cant style. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2x4 wood nailer and 18 ga galvanized steel counter flashing.

B. Mounting rail gauge shall be selected to support equipment adequately but shall be not less than 18 ga.

C. Height shall be as detailed, but not less than 8” above finished roof.

D. Equipment rails shall span minimum of 2 joists and not cantilever more than 6” where joists are used. Rails shall be level at top with pitch built in when deck slopes 1/4" per foot or greater.

2.23 PIPE ROOF PENETRATION PROTECTIONS

A. Manufacturers: Roof Products & Systems, ThyCurb or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12” OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless steel clamp.

2.24 PIPE GUIDES

A. Unless otherwise indicated, guides shall be Pipe Shields, Bergen Pre-Insulated Pipe Supports, or Rilco equal to Pipe Shields "B" Series B3000, B4000, B7000, B8000, selected by load and movement.

2.25 PIPE ANCHORS

A. Unless otherwise indicated, anchors shall be no-moment type, Shaw Pipe Shields or Rilco equal to Shaw Pipe Shields Insulated Positive Pipe Anchor Model C3000 or C4000 Series, sized to meet anchor forces shown with minimum safety factor of 3.0.

B. Contractor may fabricate anchors of steel sections suitable for location of installation and for withstanding anchor forces shown with minimum safety factor of 3.0.

2.26 CASEWORK PIPE SUPPORTS

A. Hinged pipe clamp and Strutcatcher, nylon 12 Grilamid, Clic by Litchfield International.

B. Vibration isolation pipe clamp, yellow zinc chromate finish, B-Line BVT Series Vibraclamp or Kwik-Clip by B-Line.

2.27 FIXTURE SUPPLY SUPPORT

A. Galvanized steel stud support bracket, pre-drilled tube support mounting holes, adjustable stud width, Erico TSGB or equal.

B. UV resistant nylon tube support, rated for 0°F through 130°F, resealable locking mechanism, Erico TPC or equal.

C. Support bracket and tube support to be from same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend piping hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

I. Refer to Section 20 0000 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

3.2 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4” and smaller	7’-0”
1-1/2”	9’-0”
2”	10’-0”
2-1/2”	11’-0”
3”	12’-0”
4”	14’-0”
6”	17’-0”
8”	19’-0”
10” and larger	20’-0”

C. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4” and smaller	7’-0”
1-1/2”	9’-0”
2”	10’-0”
2-1/2”	11’-0”
3” and larger	12’-0”

D. Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4” and smaller	5’-0”
1” to 1-1/4”	6’-0”
1-1/2” to 2-1/2”	8’-0”
3” and larger	10’-0”

E. Copper Tube (Domestic Water, Laboratory Water, Non-potable Water):

Pipe Size	Max Spacing
1-1/4” and smaller	6’-0”
1-1/2” and larger	10’-0”

F. Copper Tube (Domestic Water, Laboratory Water, Non Potable Water):

Pipe Size	Max Spacing
1-1/2” and smaller	6’-0”
2” and larger	10’-0”

G. Copper Tube (Medical Gases):

Pipe Size	Max Spacing
1/4”	5’-0”
3/8” and 1/2”	6’-0”
3/4”	7’-0”
1”	8’-0”
1-1/4”	9’-0”
1-1/2” and larger	10’-0”

H. Plastic Pipe

1. PVC Pipe:

Pipe Size	Max Spacing

All sizes	4’-0”

2. CPVC Pipe:

Pipe Size	Max Spacing
1” and smaller	3’-0”
1-1/4” and larger	4’-0”

3. PVDF Pipe (Waste and Vent):

Pipe Size	Max Spacing
2” and smaller	3’-0”
3” and larger	4’-0”

4. PP Pipe (Waste and Vent):

Pipe Size	Max Spacing
2” and smaller	3’-0”
3”	4’-0”
4”	4’-6”

5. PP Pipe (High Purity Water):

Pipe Size	Max Spacing
All sizes	Continuous sheet metal trough

6. PP-R Pipe (Potable and Nonpotable Water):

Pipe Size	Max Spacing
2” and smaller	4’-0”
3”	6’-0”

7. PEX-a Pipe (Potable and Nonpotable Water):

Pipe Size	Max Spacing
3” and smaller	2’-8”

a. Pipe can be supported with PEX-a Pipe Channel as an alternate. Spacing for supports with pipe channel shall be 6’ for pipes 3/4” and smaller and 8’ for pipes 1” and larger.
b. Provide copper tube size riser clamps at base of each floor and at top of every other floor with mid-floor guides for hot water systems.

c. Provide copper tube size riser clamps at base of each floor and top of every 4 floors with mid-floor guides for cold water systems.

8. Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.

I. Cast Iron Pipe:

1. Maximum hanger and support spacing shall be 10 ft for all pipe sizes. Provide minimum of one hanger per pipe section close to joint on barrel, at each pipe fitting, at change of direction and branch connections.
2. Support Cast Iron No-Hub pipe as recommended in CISPI Publication "Cast Iron Soil Pipe and Fittings Handbook, Chapter IV - Installation of Cast Iron Soil Pipe and Fittings."

J. Borosilicate Glass:

1. Maximum hanger and support spacing for borosilicate glass piping shall be 10 ft.
2. Support borosilicate glass pipe with padded hangers.

K. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

L. Spacing less than indicated above may be required to conform to building structure design or loading limitations.

M. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

N. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

O. For non-metallic pipe, follow manufacturer's installation recommendations in addition to requirements noted herein.

P. Install supports for vertical piping and anchors as recommended by pipe manufacturer.

Q. Place hangers and supports to meet requirements of Section 23 2116 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.

R. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

S. Place hangers and supports within 1 ft of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4” and larger.

T. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

3.3 RISER SUPPORTS

A. Insulated Piping:

1. Unless otherwise indicated, support vertical piping as indicated below:
2. Support vertical piping at **[bottom] [approximately midpoint]** of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at **[top] [top and bottom]** of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.
3. Guide vertical piping 2” and smaller at every floor. Guide 2-1/2” and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 23 0550 - Vibration Isolation.

B. Non-insulated Piping:

1. Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast iron pipes shall be 15 ft.
2. Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft.
3. Install riser clamps and intermediate supports as required.
4. Rest riser clamps on floor or on pipe sleeve.
5. Non-insulated piping above 120°F such as steam vents shall be supported per insulated piping requirements.

3.4 INSULATION PROTECTION SHIELDS

A. Install insulation protection shields at support points as specified under Insulated Pipe Supports.

1. Use one shield (bottom) for clevis hanger.
2. Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.5 INSULATION PROTECTION SADDLES

A. Install saddles at support points as specified under Insulated Pipe Supports. Tack weld saddle to pipe by tacking center of each point of contact. Pack saddle cavity with insulation of same type as specified for piping system.

B. Where depth of single saddle is less than specified insulation thickness, provide additional saddle tack welded to first saddle to equal insulation thickness.

3.6 INSULATED PIPE SUPPORTS

A. Install insulated pipe support at each support point of insulated pipe. Provide insulation protection shields except where saddles are used.

B. Pipe Size 1-1/2” and Smaller:

1. Use insulation protection shields. Pipe insulation specified in Section 20 0700 - Mechanical Systems Insulation shall be continuous through support points.

C. Pipe Size 2” and Larger:

1. Use pre-insulated pipe supports. Refer to Part 2 for acceptable products.

2. In lieu of pre-insulated pipe supports, field-assembled insulated pipe supports may be used. If used, submit application details including materials, thickness, compression strength, load bearing surfaces, load calculations of support assembly and total pipe weight based on support spacing.
3. Field-assembled insulated pipe supports shall consist of weight bearing insulation inserts and insulation protection shields.
4. Insulation protection saddles may be used in lieu of assembled insulated pipe supports on roller hangers/supports for hot water pipes, low pressure steam and steam condensate pipes.

3.7 PIPE FLOOR SUPPORTS

A. Unless specifically shown otherwise, use adjustable pipe saddle supports with associated stanchion similar to Anvil Fig. 264/63. Select supports properly for weight and height of pipe stand.

3.8 CONCRETE INSERTS

A. Concrete insert application, size, loading, and placement shall be this Contractor's responsibility.

B. Coordinate with General Contractor for placement of inserts before concrete pour. Minimize use of inserts and anchors after concrete pour.

3.9 CONTINUOUS INSERT CHANNELS

A. Mount continuous insert channels when used for pipe support on 8'-0" maximum centers and 2'-0" from corners.

3.10 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 3/8" or smaller and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping and ductwork. C-clamps are not allowed for hot water piping and steam and steam condensate piping, except hot water runouts to terminal heating devices.

C. C-clamps are not allowed for open web steel joist application.

D. C-clamps are not allowed for seismic application.

3.11 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

B. Determine trapeze supports spacing by the smallest pipe on trapeze.

3.12 PIPE MOUNTING PEDESTALS

A. Use for all piping on roof. Install bottom of pedestal flat on roof deck, insulate exterior of pedestal, flash and counter flash.

3.13 EQUIPMENT RAILS

A. Use for all roof-mounted equipment, which is not curb mounted. Install bottom of equipment rail flat on roof deck. Insulate exterior of equipment rail.

B. Flashing will be by General Contractor. Provide counter flashing as specified and secure to wood nailer with stainless steel truss head screws.

3.14 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be this Contractor's responsibility.

3.15 PIPE ROOF PENETRATION PROTECTIONS

A. Install at points where pipes are penetrating roof. Install as shown and according to manufacturer's installation instructions.

3.16 PIPE GUIDES

A. Install where shown on drawings.

B. For manufactured expansion devices, install minimum of 2 pipe guides at each side of manufactured pipe expansion device. Locate first guide no more than 4 pipe diameters from expansion device and second guide at 14 pipe diameters from first guide. Install intermediate guides in accordance with guide spacing data recommended by manufacturer or the following table, whichever is more stringent.

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES (FT)

	Pipe Operating Pressure			
Pipe Size (inches)	0-50 psig	51-100 psig	101-150 psig	151-200 psig
3	21	19	17	16
4	35	29	25	22
6	57	44	37	32
8	66	52	45	40
10	91	69	58	51
12	107	79	66	58
14	115	85	71	62
16	127	94	78	68

C. If anchor is located within 4 pipe diameters from expansion joints, guides need not be installed on anchor side.

3.17 PIPE ANCHORS

A. Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

B. Do not anchor piping to concrete block walls, wood, or partition walls.

END OF SECTION 200529

SECTION 200553 - MECHANICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 SUBMITTALS

A. Product Data: For identification materials and devices

B. Valve Schedules: For each piping system

C. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

A. Stencil Paint:

1. Oil-based, alkyd enamel, black color

B. Marker System:

1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton
2. Manufacturer's standard, preprinted with color coding, lettering size and length of color field according to ASME A13.1.
3. Use pressure-sensitive type or "snap-on" type.
4. "Strap-on" type may be used for piping over 6” size including insulation.

C. Valve Tags:

1. Minimum 1-1/2” diameter, 0.032” thick, polished brass or 316 stainless steel.

D. Laminated Plastic Nameplates:

1. Nameplates shall be approximately 1-1/2" x 4", 1/16” thick, and have 1/2” high lettering. Face of plastic nameplates shall be black with white letters.
2. Fasteners shall be self-tapping, stainless steel screws or contact type with permanent adhesive.

E. Underground Warning Tape:

1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton

2. Underground warning tape, 5.0 mil overall thickness, 2" width minimum, aluminum foil core where required to be detectable, bonded polyethylene jacket. Brady "Identoline" or equal.
3. Following services shall be provided with warning tape with colors and trace wire as indicated:
   a. Natural Gas: Yellow with black letters, detectable
   b. Fuel Oil: Yellow with black letters, detectable
   c. Water Lines: Blue with black letters, **[non]** detectable
   d. Sanitary Sewer: Green with black letters, **[non]** detectable
   e. Storm Sewer: Green with black letters, **[non]** detectable

PART 3 - EXECUTION

3.1 GENERAL

A. After painting and/or covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

B. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker materials for those applications.

C. Coordinate, obtain and confirm mechanical systems identification criteria and requirements from Owner.

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe identification on each system.

B. Place flow directional arrows at each pipe identification location.

C. Identify all piping (except medical gas) not less than once every 25 ft, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.

D. Identify medical gas piping systems identified in Section 22 6316 in accordance with NFPA 99.

1. Medical gas piping system labels shall be located as follows:
   a. At intervals of not more than 20 ft
   b. At least once in every room
   c. On both sides of walls or partitions penetrated by piping
   d. At least once every story transversed by risers

2. Medical gas piping shall be labeled by stenciling or adhesive markers that identify patient medical gas, support gas, or vacuum system and include:
   a. Gas/Vacuum system name or chemical symbol per NFPA 99 Table 5.1.11
   b. Gas/Vacuum color code per NFPA 99 Table 5.1.11
   c. Operating pressure in addition to gas name where positive pressure piping systems operate at pressures other than standard pressures defined by NFPA 99 Table 5.1.11.

3. Medical gas piping shall not be painted.

E. Identify piping by stenciling. Height of lettering shall be same as pipe diameter up to maximum of 1” in height. When finished color of piping is dark, stenciling shall be on white background.

F. Identify piping with marker system.

1. For "strap-on" type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

3.3 VALVE IDENTIFICATION

A. Identify valves with brass tags bearing system identification and valve sequence number in 1/2” black characters. Attach tag to valve body with brass jack chain and "S" hook for brass tag and SS jack chain or SS braided wires with swag sleeves and "S" hook for stainless steel tag. Non-metallic fasteners are not allowed.

B. Valve numbers shall be prefixed with corresponding piping system identification in 1/4” black letters.

C. Valve tags are not required at terminal devices unless valves are greater than 10 ft from device or located in another room not visible from terminal unit.

D. Furnish typewritten valve schedule indicating valve number, fixtures, equipment or areas served by each numbered valve and incorporate in O&M Manuals.

3.4 STEAM TRAP IDENTIFICATION

A. Identify steam traps as specified for valve identification.

3.5 DUCT SYSTEM IDENTIFICATION

A. Install duct identification for each supply, return and exhaust air system.

B. Identify all ductwork not less than once every 25 ft and not less than once in each room.

C. Identify duct system by stenciling exterior of duct or insulation jacket by name as either “Supply Air (AHU-x), “Return Air (RF-x)”, or “Exhaust Air (EF-x)”. “-x” shall indicate system number (e.g. AHU-1).

D. Stencils shall be 2” (min) lettering, shall include direction arrow and shall be on bottom of duct or insulation jacket such that it is visible from floor below.

E. Do not identify systems exposed in architecturally “finished” spaces.

F. Hazardous ductwork shall have appropriate warning signs posted to protect personnel from exposure.

3.6 EQUIPMENT IDENTIFICATION

A. Identify major equipment, including air handling units, fans, boilers, chillers, heat exchangers, air terminal devices, pumps, water heaters, tanks, compressors, etc.

B. Identify equipment by stenciling equipment number and service in 2” high letters.

C. Identify equipment with marker system.

D. Identify equipment with laminated plastic nameplates.

E. Identify control equipment and panels with laminated plastic nameplates.

F. Nameplate Markings:

1. Identify model number, size, capacity, electrical characteristics, serial number, along with other items scheduled for equipment on drawings.
2. Indicate motor horsepower, voltage, phase, cycles, RPM, full load amps, locked motor amps, frame size, manufacturer’s name and model number, Service Factor, Power Factor, efficiency, minimum circuit amps, minimum feeder conductor size, disconnect or fuse size, refrigerant, and other pertinent information.

G. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if original nameplates are not located for easy reading.

3.7 ACCESS PANEL IDENTIFICATION

A. Identify each service opening or access opening for fire, smoke, and fire/smoke damper with minimum 1/2” high letters indicating type of damper.

B. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

3.8 SPRINKLER ZONE CONTROL VALVE IDENTIFICATION

A. Identify sprinkler zone control valves with laminated plastic nameplates. Nameplate shall include name of sprinkler zone served and description of area served.

B. Identify inspector’s test valve with laminated plastic nameplate if valve is located remote from sprinkler control valve. Nameplate shall include name of sprinkler zone served.

3.9 UNDERGROUND WARNING TAPE

A. Install detectable warning tape 4” to 6” below grade to allow for accurate above surface detection.

B. Install non-detectable warning tape 6” to 12” below grade.

C. Repair and replace existing underground warning tape where disturbed by excavation.

END OF SECTION 200553

SECTION 200700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 23 3114 - Ductwork (Duct Lining)

1.2 [REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]**

1.3 DESCRIPTION

A. Provide insulating materials and accessories as required for mechanical systems as specified below.

B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.4 DEFINITIONS

A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

B. Unless otherwise indicated, unit of thermal conductivity is Btu·in/(h·ft^2·°F).

C. Interstitial spaces are considered as concealed areas.

D. When used in this section, the term Chilled Water shall include Chilled Beam Water as well as Chilled Water.

1.5 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes, each ductwork system, and all equipment including, but not limited to, the following:

1. Manufacturer's name
2. Schedule of insulating materials
3. Insulation material and thickness
4. Jacket

5. Adhesives
6. Fastening methods
7. Fitting materials
8. Intended use of each material
9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
10. Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)
11. Literature data sheet from sealants and adhesive manufacturers stating VOC compliance with USGBC LEED IEQ 4.1.
12. Literature data sheet from coatings and mastics (including lagging adhesives) manufacturers stating VOC compliance with USGBC LEED IEQ 4.2.
13. All other appropriate data

1.6 DELIVERY, STORAGE AND HANDLING

A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation:

1. Owens Corning, Johns Manville, Manson, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

B. Coatings, Mastics, Sealants and Adhesives:

1. Foster, Childers, Vimasco, Miracle or Pittsburgh Corning

2.2 MATERIALS

A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread index of not over 25 and smoke developed index no higher than 50.

B. Unless otherwise indicated, all products, material itself or on composite basis, shall have flame spread index not more than 25 and smoke developed index not more than 50, when tested in accordance with ASTM E-84 or UL723.

C. Pipe insulation which is not located in air plenum may have flame spread rating not over 25 and smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

D. Outdoor insulation may have flame spread rating not over 75 and smoke developed rating not higher than 450.

E. Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36.

2.3 INSULATION

A. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb/ft^3 thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.

D. Filling and finishing cement shall be Super-Stik by PK Insulation MFG Co., or Ryder MW, with dry density of no more than 24 lb/ft^3, thermal conductivity of 0.74 at 500°F mean temperature, and service temperature to 1900°F.

E. Type A Insulation (Closed Cell Elastomeric Thermal Insulation):

1. Minimum nominal density of 6 lb/ft^3, thermal conductivity not more than 0.25 at 75°F mean temperature, maximum water vapor transmission of 0.06 perm-inch and suitable for temperatures from -70 to 220°F, Armacell Model AP/Armaflex, K-Flex USA, or Aeroflex Model Aerocel.

F. Type C Insulation (Ceramic Fiber):

1. Formed from alumina and silica materials, nominal 8 lb/ft^3 density, suitable for temperature to 2000°F continuous, thermal conductivity not more than 0.73 at 1000°F mean temperature, equal to Morgan Thermal Ceramics Superwool Plus.

G. Type F Insulation (Flexible Glass Fiber):

1. Minimum density of 0.75 lb/ft^3 with thermal conductivity of not more than 0.29 at 75°F mean temperature, and suitable for temperatures to 250°F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite EQ Type 75, Knauf Atmosphere Duct Wrap.

H. Type FR Insulation (Fire Resistive Duct Wrap):

1. Wrap material shall have fire resistive rating of 2 h and shall be Fire Master Fast Wrap XL duct wrap by Thermal Ceramics or similar products by Unifrax or 3M. Wrap shall be 1-1/2" thick, service range up to 2000°F and R-value per ASTM C518, 4.15 per inch at 70°F.
2. Wrap shall have the following requirements:
   a. Through-penetration firestop systems for air ducts, ASTM E814, 2 h F and T Rating.
   b. Non-combustibility, ASTM E136
   c. ISO-6944, Fire Resistance Tests - Ventilation Ducts

I. Type G Insulation (Cellular Glass):

1. 100% cellular glass cells with no organic material, noncombustible, 0.00 perm-inch permeability, 7.5 lb/ft^3 average density, compression strength 90 psi, thermal conductivity

of not more than 0.31 at 50°F mean temperature and service temperature of 900°F. Pittsburgh Corning Foamglas or approved equal.

J. Type H Insulation (High Temperature Block or Pipe):

1. Hydrous calcium silicate, suitable for temperatures to 1200°F, thermal conductivity not more than 0.50 at 400°F, dry density 13 lb/ft^3 minimum and compressive strength 100 psi. Industrial Insulation Group (formerly Johns Manville), Thermo-12 Gold.

K. Type KG Insulation (Kitchen Grease Duct Wrap):

1. Wrap material shall be suitable for kitchen grease duct wrap meeting IMC 2006 and shall be Fire Master Fast Wrap XL by Thermal Ceramics or similar products by Unifrax or 3M. Wrap shall be two layers, each 1-1/2” thick maximum, service range up to 2000°F and R-value per ASTM C518, 4.15 per inch at 70°F.
2. Wrap shall have the following requirements:
   a. Through-penetration firestop systems for air ducts, ASTM E814, 2 h F and T Ratings.
   b. Passes ASTM E2336 test standard, shall have ICC ESR.

3. Duct access doors shall be furnished by duct wrap manufacture as part of duct wrap system. Access doors shall pass ASTM E2336 test standard.

L. Type M Insulation (Mineral Wool Pipe Covering):

1. Mineral fiber premolded pipe insulation, in accordance with ASTM C-547, Type II, Grade A, nominal 8 lb/ft^3 density, water resistant, non-wicking, suitable for continuous temperature through 800°F, thermal conductivity not more than 0.31 at 200°F and 0.41 at 400°F mean temperature, Roxul ProRox PS 960, or IIG MinWool-1200.

M. Type P Insulation (Expanded Polyisocyanurate):

1. Continuously molded rigid polyisocyanurate foam insulation meeting requirements of ASTM C-591, with thermal conductivity of not more than 0.19 at 75°F mean temperature, minimum nominal density of 2 lb/ft^3, minimum compressive strength of 24 psi, maximum water vapor transmission of 4.0 perm-inch, maximum water absorption of 2% by volume, and suitable for temperature of plus 300°F down to -297°F. Insulation shall have factory-applied jacket with SSL. Trymer 2000 XP by ITW, Dyplast ISO-C1, or approved equal.

N. Type PP Insulation (Phenolic):

1. Rigid closed cell, minimum nominal density of 2.2 lb/ft^3, thermal conductivity of not more than 0.15 at 75°F, minimum compressive strength of 31 psi and maximum water vapor permeability 0.117 perm-inch, maximum water absorption of .5% by volume, rated for service range of -290°F to 250°F.
2. Koolphen K phenolic foam insulation by Kooltherm Insulation, Resolco Insulphen rigid phenolic insulation by Resolco Inc., or Trymer Green by ITW Insulation.

O. Type R Insulation (Rigid Glass Fiber):

1. Minimum nominal density of 3 lb/ft^3 with thermal conductivity of not more than 0.23 at 75°F mean temperature.

2. Pipe insulation shall be premolded type in accordance with ASTM C547 Type I, suitable for temperatures to 850°F, Johns Manville Micro-Lok, Owens Corning Fiberglas ASJ/SSL-II or Knauf Earthwool 1000° pipe insulation.
3. Duct and equipment insulation shall be in accordance with ASTM C612, Type IA and IB, suitable for temperatures to 450°F, Johns Manville Spin-Glas Type 814, Owens Corning Type 703, Knauf Insulation Board.
4. Pipe and tank wrap faced with specified jacket may be used for equipment and round ducts insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

P. Type RR Insulation (Rigid Glass Fiber):

1. Minimum nominal density of 6 lb/ft^3 with thermal conductivity of not more than 0.22 at 75°F mean temperature. Insulation shall be suitable for temperatures to 450°F. Minimum compressive strength at 10% deformation shall be 200 lb/ft^2, Johns Manville Spin-Glas Type 817 or Owens Corning 705.
2. GA4000 Polyisocyanurate Insulation by Celotex may be used for Type RR insulation specified for exterior rectangular ductwork, provided minimum thickness is 3/4” and R-value is not less than R-value specified.
3. Pipe and tank wrap faced with specified jacket may be used for equipment and round duct insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

Q. Type S Insulation (Extruded Polystyrene):

1. Rigid closed cell, minimum nominal 1.6 lb/ft^3 density, thermal conductivity not more than 0.26 at 75°F mean temperature, minimum compressive strength of 20 psi based on 10% deflection, maximum water vapor transmission 1.5 perm-inch, water absorption 0.5% by volume, rated for service range of -290°F to 165°F.
2. Manufacturers: Dow Chemical Styrofoam brand insulation Billet or approved equal

R. Type T Insulation (Mineral Fiber Fireproofing):

1. Nominal 8 lb/ft^3 density with fire hazard classification flame spread of no more than 15, and smoke development of 0, thermal conductivity of not more than 0.23 at 75°F mean temperature, rated for service temperature to 1200°F. US Gypsum Thermafiber, Roxul or Fibrex duct insulation.

2.4 JACKETS

A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 Procedure A.

B. Type A-1 Jacket (Aluminum Roll Jacketing):

1. Factory fabricated 0.016” thick, ASTM B209, Type 3003 or 3105, stucco embossed aluminum jacket with integrally bonded moisture barrier/retarder consisting of 3 layers of polymer films with total thickness of 3 mil
2. Fitting covers shall be factory fabricated from not lighter than 0.024" thick, Type 3003 or 1100 aluminum. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.
3. Jacketing system shall be similar to ITW Pabco/Childers or Insul-Mate by RPR Products, Inc.

C. Type A-2 Jacket (Aluminum Roll Jacketing – High Temperature Application)

1. Factory fabricated 0.016” thick, ASTM B209, Type 3003 or 3105, stucco embossed aluminum jacket. Due to potential for high temperature exposure, jacket shall be absent of additional moisture barrier/retarder of any kind.
2. Fitting covers shall be factory fabricated from not lighter than 0.024" thick, Type 3003 or 1100 aluminum. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.

D. Type D-1 Jacket:

1. Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ", Johns Manville "AP", Knauf “ASJ”.

E. Type D-2 Jacket:

1. Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK", Knauf “FSK”.

F. Type D-3 Jacket:

1. Self-adhering, multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and minimum 40 mil rubberized asphalt waterproofing compound, similar to Peel and Seal or Flex Clad 400 by MFM Building Products Corp. or Alumaguard 60 by Polyguard or Alumaguard LT all weather.
2. Venture Clad 1577 CW, Alumaguard Lite or Foster Vaporfas 62-05
   a. Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E-96, mold inhibitors incorporated and UV stable.
   b. Jackets shall have **[white][embossed aluminum][embossed white][tedlar]** finish.

G. Type E-2 Jacket:

1. Heat sealable, multi-ply laminate consisting of layer of asphalt, glass fiber reinforcement, second layer of asphalt, aluminum foil layer, third layer of asphalt, and polyester outer film. Pittsburgh Corning Pittwrap. Minimum total thickness shall be 125 mils.
2. Self-sealing, non-metallic sheet consisting of special bituminous resin reinforced with woven glass fabric and 1 mil thick aluminum film. Pittsburgh Corning Pittwrap SS. Minimum total thickness shall be 70 mils.

H. Type E-3, Jacket

1. Self-sealing, modified bituminous membrane reinforced with glass fabric and 1 mil thick aluminum film. Pittsburgh Corning Pittwrap CW Plus. Minimum total thickness shall be 50 mils.

I. Type P-1 Jackets:

1. Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with burst strength of 1.5 Joules(50 beach units) minimum and tensile strength 45 lbs/in minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ-SSL", Johns Manville "ASJ" and Knauf ASJ+.

J. Type P-2 Jackets:

1. Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E-96, mold inhibitors incorporated and UV stable, Venture Clad 1577 CW or Alumaguard Lite.
2. Jackets shall have **[aluminum][white][embossed aluminum][embossed white][tedlar]** finish.

K. Type SS-1 Jacket (Protective Insulation Shield):

1. Factory fabricated 0.01” thick, ASTM A-240, Type 304 stainless steel, 2B mill finish jacket with integrally bonded moisture barrier/retarder consisting of 3 layers of polymer films with total thickness of 3 mil,.
2. Fitting covers shall be factory fabricated from not lighter than 0.016" thick, Type 304 or Type 316 stainless steel. For large pipes, where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.
3. Jacketing system shall be equal to ITW Pabco/Childers or InsulMate by RPR Products, Inc.

L. Type SS-2 Jacket (Stainless Steel Roll Jacketing – High Temperature Application)

1. Factory fabricated 0.01” thick, ASTM A-240, Type 304 stainless steel, 2B mill finish jacket. Due to potential for high temperature exposure, jacket shall be absent of additional moisture barrier/retarder of any kind.
2. Fitting covers shall be factory fabricated from not lighter than 0.016" thick, Type 304 or Type 316 stainless steel. For large pipe where factory fabricated fitting covers are not available, Contractor shall fabricate fitting covers from like sheet materials.
3. Jacketing system shall be similar to ITW Pabco/Childers or Insul-Mate by RPR Products, Inc.

M. Type S-1 Jacket:

1. Saran Vapor Retarder Film with self-sealing lap (SSL), ASTM C-755 and C-1136, 6 mil thickness. Permeance shall not exceed 0.01 perms, equal to Dow Saran 540 CX.
2. Elbows, fittings, valves and butt joints shall be wrapped with 3 layers of Dow Saran 520 Vapor Retarder tape.
3. Provide PVC jacket (Type V-1) over Saran tapes for exposed elbows, fittings and valves.

N. Type V-1 Jacket:

1. Fire retardant and UV resistant PVC in minimum [20 mil (0.02")][30 mil (0.03”)] thickness consisting of preformed fitting covers, preformed end terminations, and sheet material for straight runs of pipe. Jacketing system shall be suitable for indoor and outdoor application in temperature range of -35°F to 150°F. Material when installed according to manufacturer's instructions shall provide complete vapor barrier and readily cleanable surface while meeting Federal CGMP requirements.

2. Jacketing system shall be equal to Johns Manville Zeston/Perma-Weld System or Speedline Smoke Safe. Similar product by PROTO will be acceptable.

2.5 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Adhesives and sealants shall comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.1.

B. Coatings and mastics shall comply with VOC limits set forth by Green Seal BS-11 and comply with the South Coast Air Quality Management District (SCAQMD) Rule #113; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.2.

C. Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.

D. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

E. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.

1. Foster 30-33
2. Childers CP-33
3. Vimasco 749

F. Weather Barrier Breather Mastic: Above ambient insulation. Permeance shall be greater than 1.0 perms at 1/16” dry film thickness per ASTM E96.

1. Foster 46-50 Weatherite
2. Childers CP-10/CP-11 Vi Cryl
3. Vimasco WC-5

G. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.

1. Foster 30-36
2. Childers CP-50 AMV1
3. Vimasco 713

H. Metal jacketing sealant for aluminum jacketing:

1. Foster 95-44 Elastolar
2. Childers CP-76 Chil Byl
3. Pittsburgh Corning 727

I. Insulation joint sealant for Type P, Type PP, and Type G insulation:

1. Foster 95-50 Flextra
2. Childers CP-76 Chil Byl
3. Pittsburgh Corning CW Sealant

J. Glass fiber fabric reinforcing shall be 10 x 10 mesh similar to Childers Chil Glas #10 or Foster Mast A Fab.

K. Wire mesh reinforcing shall be 22 ga, 1” galvanized.

L. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

M. Finishing cement shall be ASTM C449.

N. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373, Childers CP-82 or Foster 85-75.

O. Weather-resistant protective finish for Type A insulation shall be equal to Armstrong WB Armaflex finish or Foster 30-64 elastomeric coating.

2.6 METAL BANDS AND WIRES

A. Aluminum bands shall be 0.5" x 0.020” up to 48” diameter and 0.75" x 0.020” over 48” diameter.

B. Stainless steel bands shall be 0.5" x 0.015” or 0.75" x 0.015”.

C. Stainless steel wires shall be 16 ga.

2.7 INSULATION FASTENERS

A. Insulation fasteners shall be cup head weld pins, galvanized low carbon steel, minimum 12 ga (0.105”) pins.

B. Washer edge shall be beveled.

C. Fasteners shall be stainless steel for stainless steel ductwork application.

D. Insulation fasteners using adhesive are not allowed.

2.8 REMOVABLE INSULATING BLANKETS

A. Custom designed removable, reusable, flexible, blanket thermal insulation system.

B. Acceptable Manufacturers: Thermal Energy Products, Inc., Advanced Thermal Corp., Temptec and Remco Technology, Inc.

C. Removable insulation system shall be custom designed for each individual item to provide close contour fit. Overlapping seams and gaps are not acceptable.

D. Removable insulation shall be designed to overlap adjoining pipe insulation by 2".

E. Insulation: Minimum 2" thick, 2.4 lb/ft^3 density, 1000°F continuous service temperature thermal insulating wool; Owens Corning Fiberglass or equal.

F. Interior and Exterior Fabric: Minimum weight 17.5 oz/sq yd silicone rubber coated fiberglass cloth.

G. Securement: Blanket seams shall be closed with buckle and strap assembly (D ring closure).

H. Identification/Tagging: Label each removable insulation device with plastic or 304 stainless steel tag with raised letters. Tag as directed by Owner.

2.9 ACOUSTICAL BARRIER MATERIALS

A. Acoustical barrier material shall be similar to Kinetics Model KNM-100ALQ. Barrier material shall have acoustic ratings of STC-28, 1.0 lb/ft^2 nominal density, flame spread index less than 25, smoke developed index less than 50, and minimum continuous operating range from 40°F to 220°F.

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB)					
Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
13	16	24	33	43	49

PART 3 - EXECUTION

3.1 APPLICATION

A. Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

Piping System							
			Insulation Thickness According to Pipe Size				
Service	Jacket Type	Insulation Type	3/4" and less	1" - 1-1/4"	1-1/2" - 3"	4" - 6"	8" and Larger
Heating Hot Water (105-140°F)	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
Heating Hot Water (141-200°F)	P-1	R	1-1/2"	1-1/2"	2"	2"	2"
Heating Hot Water (201-250°F)	P-1	R	2-1/2"	2-1/2"	2-1/2"	3"	3"
Heated Glycol	P-1	R	1-1/2"	1-1/2"	2"	2"	2"
Chilled Water	P-1	R	1"	1"	1-1/2"	1-1/2"	2"
Chilled Water	-	A	1"	1"	1-1/2"	1-1/2"	2"
Chilled Water	S-1	P	1"	1"	1"	1"	1-1/2"
Chilled Water	S-1	PP	1"	1"	1"	1"	1-1/2"

Chilled Water (Inside AHU housing)	V-1	PP	1"	1"	1"	1"	1-1/2"
Chilled Water (Interior)	P-1	G	1"	1-1/2"	2"	2"	2-1/2"
Chilled Water (Exterior)	P-2	P	1"	1"	1"	1"	1-1/2"
Chilled Water (Exterior)	P-1 & A-1	S	1"	1-1/2"	1-1/2"	2"	2"
Chilled Water (Underground - direct buried)	E-3	G	1-1/2"	1-1/2"	2"	2"	2-1/2"
Condenser Water (Interior) (50°F and lower or used for water side economizer)	S-1	P	1"	1"	1"	1"	1-1/2"
Refrigerant Suction Lines and Hot Gas By-pass Line if Used (Interior)	-	A	1"	1"	1"	1"	1-1/2"
Refrigerant Suction Lines and Hot Gas By-pass Line if Used (Exterior)	P-2	A	1"	1"	1"	1"	1-1/2"
Cooling Coil Condensate Drain	P-1	R	1"	1"	1"	1"	1"
		Type A 3/4" thick insulation may be used.					
Low Pressure Steam and Condensate (201-250°F)	P-1	R	2-1/2"	2-1/2"	2-1/2"	3"	3"
High Pressure Steam and Condensate (251-350°F)	P-1	R	3"	4"	4-1/2"	4-1/2"	4-1/2"
High Pressure Steam and Condensate (351-450°F)	P-1	R	4-1/2"	5"	5"	5"	5"

High Pressure Steam and Condensate (Operating Temp. over 450°F)	P-1	M	4-1/2"	5"	5"	5"	5"
Condensate Pump Discharge (141-200°F)	P-1	R	1-1/2"	1-1/2"	2"	2"	2"
Steam and Condensate	A-1	G	3"	4"	4"	5"	5"
Steam and Condensate (Underground - direct buried)	E-2	G	3"	4"	4"	5"	5"
Boiler Feed (201-250°F)	P-1	R	2-1/2"	2-1/2"	2-1/2"	3"	3"
Boiler Blow Down	P-1	R	1"	1"	1"	1"	1"
Heated Fuel Oil	P-1	R	1"	1"	1"	1-1/2"	1-1/2"
Snow Melting (Except piping encased in concrete)	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
Engine Generator Remote Radiator	P-1	R	1-1/2"	1-1/2"	2"	2"	2"
Piping Between Separation Chamber and Manifolds of Steam Jacketed Humidifiers	P-1	R	2-1/2"	2-1/2"	2-1/2"	3"	3"
Steam Safety Valve Vent Piping located within 8' above floor	P-1	R	1"	1"	1"	1"	1"
Steam Safety Valve Vent Piping	P-1	R	1"	1"	1"	1"	1"
[Domestic] [Potable] Cold Water	P-1	R	1"	1"	1"	1"	1"
	--	A	3/4"	3/4"	3/4"	3/4"	3/4"

(Type A Insulation is an option)

[Domestic] [Potable] Hot Water and Hot Water Return (105-140°F)	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
	--	A	1"	1"	1-1/2"	1-1/2"	NA
	(Type A insulation is an option.)						
[Domestic] [Potable] Hot Water and Hot Water Return (141-200°F)	P-1	R	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Tempered Water	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
[Laboratory] [Nonpotable] Cold Water	P-1	R	1"	1"	1"	1"	1"
	--	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
	(Type A insulation is an option.)						
[Laboratory] [Nonpotable] Hot Water and Hot Water Return (105-140°F)	P-1	R	1"	1"	1-1/2"	1-1/2"	1-1/2"
	--	A	1"	1"	1-1/2"	1-1/2"	NA
Storm **[and overflow]** piping including roof drain body.	P-1	R	NA	1"	1"	1"	1"
	--	A	NA	3/4"	3/4"	3/4"	NA
	(Type A insulation is an option.)						
Clearwater Waste	P-1	R	1"	1"	1"	1"	1"
	--	A	3/4"	3/4"	3/4"	3/4"	NA
	(Type A insulation is an option.)						
Piping Provided with Heat Tracing	P-1	R	1"	1-1/2"	2"	2"	2"

Insulation thickness shall be the greater thickness specified for piping system or thickness specified above.

MRI Quench Vent	For first 10 ft provide two layers of 1" Type A insulation, all seams and joints staggered. Apply minimum 0.002" aluminum foil with complete adhesive coverage between first layer and second layer. Provide single layer of 2" Type A insulation for remainder of vent pipe.
Insulated Exterior Piping	Unless otherwise indicated, provide protective insulation shield (Type A-1 jacket) in addition to pipe insulation and jacket specified in this schedule.
Insulated Piping Subject to Abuse as Indicated on Drawings	Provide Type H insulation for hot piping and Type P insulation for cold piping with V-1 jacket in lieu of specified insulation/jacket with same insulation thickness.

Ductwork/Equipment System

Service	Jacket Type	Insulation Type	Insulation Thickness
OA Ducts Exposed	D-1 or D-2	R	2"
OA Ducts Concealed	D-2	R	2"
Mixed Air (Outside Air & Return Air Ducts & Plenum)	D-1	R	1-1/2"
Supply Ducts Exposed	D-1	R	1-1/2"
Supply Ducts Concealed	D-2	F	2"
Exhaust or Relief Ducts from Control or BD Damper to Outside Wall or Roof	D-1	R	1-1/2"
Return and Relief Ducts in Equipment Rooms	D-1	R	1-1/2"
Return Ducts in **XXX**	D-2	F	2"
Supply Ducts Exterior	D-3	RR	2"
Return Ducts Exterior	D-3	RR	2"
Exhaust Ducts Exterior	D-3	RR	2"
Exhaust Ducts Serving Cold Rooms	---	A	1"
Exhaust Ducts Downstream from Heat Recovery Units - Exposed	D-1	R	1"
Exhaust Ducts Downstream from Heat Recovery Units - Concealed	D-2	F	2"
Fume Exhaust Ducts Exterior up to Exhaust Fan Inlet.	D-3	RR	2"
Kitchen Grease Exhaust Ducts	---	KG	(Refer to Part 2)
Ductwork Covered with 2 h Rated Wrap	---	FR	(Refer to Part 2)
Heat Recovery Units	D-1	R	1"
Breechings	E-1	H	3"
Breechings	P-1	R	2"
Flue Gas Recirculation Ducts for Boilers	A-1	H	4"
Engine Generator Set Exhaust Pipe (up to 1200°F)	A-1	H	4"

Engine Generator Set Muffler (up to 1200°F)	A-1	H	4"
Engine Exhaust Pipe (over 1200°F)	A-2	Air Gap (1st layer) 304 SS Liner (2nd layer) C (3rd layer) M (4th Layer)	1"2" (3rd layer) 3" (4th layer)
Engine Exhaust Muffler (over 1200°F)	A-2	Air Gap (1st layer) 304 SS Liner (2nd layer) C (3rd layer) M (4th Layer)	1"2" (3rd layer) 3" (4th layer)
Air Separators & Water Filters (Hot Water)	P-1	R	2"
Air Separators & Water Filters (Chilled Water)		A	1"
Heat Exchangers	P-1	R	2-1/2"
Heat Exchangers (Plate and Frame Type)	---	A	1"
Condensate Receivers	P-1	R	2"
Pressure operated condensate pumps	P-1	R	2"
(Pump manufacturer may furnish removable insulation blanket as an option.)			
Flash Tanks	P-1	R	2"
Blowdown Separator	P-1	R	2"
Chilled Water Storage Tank		A	1"
Storage Tanks		A	1"
Chiller Evaporator Shell	---	A	1"
Water Cooled Condenser Shell	---	A	1"
Chilled Water Pump Heads (Removable)	(Refer to specification)	A	1"
Chiller Water Boxes (Removable)	---	A	1"
Chilled Water Expansion Tanks	---	A	3/4"
Humidifier Separator	P-1	R	2"
Raw Water Make Up Tanks		A	1"
Water Softener Mineral Tanks		A	1"

A. Type F insulation with Type D-2 jacket may be used in lieu of Type R insulation with Type D-1 jacket for ductwork located 6 ft or higher above floor in mechanical equipment rooms. Horizontal

ducts that are not completely 6 ft above floor shall be insulated with Type R insulation as specified for its entirety.

3.2 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.

F. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.

G. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.

H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 20 0000 - General Mechanical Requirements and Section 20 0573 - Mechanical Systems Firestopping.

J. Insulate water piping within casework up to penetration of casework pipe chase at fixture stop. Insulate water piping within walls up to pipe penetration through the wall at fixture stop when serving wall-mounted fixtures. Termination of insulation shall be in neat and workman like manner with insulation jacket cap.

K. Insulate the following systems for complete vapor barrier protection:

1. Chilled Water
2. Refrigerant
3. Cooling coil condensate drain
4. Storm
5. Clearwater Waste
6. Cold Water
7. All insulated ductwork
8. All equipment with surface temperature below 65°F

L. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.3 GLASS FIBER FABRIC COVERING (TYPE E-1 JACKET)

A. Glass fiber fabric shall be fitted without wrinkles.

B. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 h.

C. Apply adhesive and coating in accordance with manufacturer's recommendations.

D. All seams shall overlap not less than 2".

3.4 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

B. Laps on factory-applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or shall be pressure sealing type lap.

C. Cover joints with factory furnished tape (3" minimum width) to match jacket. Cement firmly with lap adhesive. On systems requiring a vapor barrier (ASJ), vaporseal all longitudinal and butt joints ASJ/Saran seams with 4” wide coat of vapor barrier mastic.

D. Where staples are used, they shall be on 6" maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic.

E. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F, one piece PVC fitting covers, minimum thickness of 20 mil, may be used. Fitting covers located in mechanical rooms within 8 ft above floor shall be 30 mil thickness. Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match those of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

F. Stove pipe style insulation on elbows (Detail A on Plate 2-200 of MICA 8th Edition) is not allowed. It may be used for closed cell elastomeric insulation.

G. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

H. For pipes 1-1/2" and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

I. For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required,

this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on hot and cold systems at pipe supports.

J. For pre-insulated pipe supports and insulation protection shields, refer to Section 20 0529 - Piping and Equipment Supporting Devices.

K. For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

L. Where mechanical grooved pipe connections are used in piping system, insulate couplings as specified for pipe.

M. Piping, fittings and valves not to be insulated:

1. Heating hot water piping inside fin tube radiation enclosures
2. Control valves and balancing valves for heating terminal devices
3. Valves furnished with removable insulation/jacket
4. Steam system traps

3.5 EQUIPMENT INSULATION

A. For equipment requiring **[Type H][Type H, Type M or Type C]** insulation such as breechings, stacks, exhaust pipes and mufflers, apply insulation to equipment and secure with stainless steel bands with tightly butted joints as recommended by manufacturer. Where multiple layers of insulation are required, stagger and secure each layer with stainless steel bands.

B. Install removable insulation where access is required for cleaning, repair and inspection, including pump heads and strainers. Construct removable insulation with Type A insulation for cold equipment and Type R insulation with V-1 jacket for hot equipment. Do not apply bonding adhesive to equipment surface.

C. Provide removable insulating blankets on expansion joints.

D. Do not insulate over equipment nameplates or ASME stamps. Bevel and seal insulation at these locations.

E. Water chiller insulation shall include insulation of evaporator shell, water boxes and other miscellaneous piping and/or equipment as directed by equipment supplier. Provide removable insulation with Type A insulation at chiller water boxes. Verify that chillers are fully charged with refrigerant before insulating.

F. Equipment not to be insulated:

1. Equipment furnished with factory insulation.

3.6 DUCTWORK AND COMPONENTS

A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcing members.

B. For support points of rectangular or oval ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.

C. Flexible glass fiber insulation (Type F) may be installed outside of support for rectangular or oval ducts having width 60" or smaller and supported with strap hangers, provided that vapor barrier integrity is maintained at strap penetration.

D. For support points of round ducts smaller than 16" diameter, weight-supporting insulation is not required for either rigid or flexible glass fiber insulation.

E. For support points of round ducts 16" diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.

F. Flexible glass fiber insulation (Type F) may be installed outside of support for round ducts 24" diameter or smaller, provided that vapor barrier integrity is maintained at rod penetration.

G. Securing glass fiber insulation (Type F, R, and RR) for rectangular or oval ductwork.

1. Horizontal ductwork:
   a. Secure to bottom of duct where duct width is 24" diameter or greater.
   b. Secure to sides of duct where duct side is 24" diameter or greater.

2. Vertical ductwork:
   a. Secure to all sides where duct width is 18" diameter or greater.

3. Install fasteners as required to secure, but not over 18" on center and within 3" of butt joint or edge.
4. Fastener shall be weld pin mechanical type.

H. Fastening insulation anchors to ductwork with adhesives is not allowed. Where weld pin fasteners are used, install them without damage to interior galvanized surface. Where weld pin fasteners cannot be used, use other type of fasteners such as metal bands.

I. Where insulation is required for ductwork, provide insulation over entire ductwork system, including system components such as filters, mixing air chambers, sound attenuators, air measuring stations, reheat coils, etc. For fire dampers, smoke dampers and combination F/S dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation.

J. Provide insulation over supply air diffusers, grilles and unlined boots after termination point of flexible ducts or rigid duct insulation to prevent from sweating.

K. Where vapor barrier jackets are specified, pins and staples if used shall be jacketed over with matching material using 4" tape. Where staples are used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic. Vaporseal insulation seams, punctures, and tears with two 4” wide coats of vapor barrier mastic.

L. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.

M. For other than factory-applied vapor barrier jackets, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For surfaces not requiring vapor barrier jackets, apply 2 coats of weatherproof breather mastic with glass fiber reinforcing fabric after application of insulation cement. Apply coating in accordance with manufacturer's recommended procedure.

N. D-1 jackets:

1. Butt together joints and seams firmly, cover with glass fiber fabric 4" minimum width.

O. D-2 jackets:

1. Butt together joints and seams firmly and cover with 4" wide FSK tape.

P. D-3 jackets:

1. Install jacket in strict accordance with manufacturer's installation requirements.
2. For rectangular ducts, overlap bottom half jacket and top half jacket at each side of duct at least 4" (bottom inside top outside at overlap).
3. For round ducts, wrap duct insulation continuously with spiral shaped overlapping. Overlap at least 4".
4. Use welded stickpins for Type D-3 jacketing wider than 24" in width alongside and bottom surfaces of ducts. Retainers of stick pins shall be covered with Type D-3 patch, minimum 4" square, once retainer cup is in place on stick pin.

Q. Acoustical Barrier Materials:

1. Provide 2" thick Type R insulation with Type D-1 jacket as inner layer. Over insulation install acoustical barrier materials as outer layer in accordance with manufacturer’s installation instruction.
2. For ductwork specified with Type F insulation, replace it with insulation specified above.
3. Refer to plans for ductwork requiring acoustical barrier materials.

R. Ductwork not to be insulated:

1. Internally lined ductwork
2. Ductwork components with factory installed insulation
3. Exposed supply and return ductwork in **[shops] [gym] [air conditioned spaces] [XXX]**

3.7 PROTECTIVE INSULATION SHIELD (A-1 JACKET) FOR PIPE JACKETS EXTERIOR TO BUILDING

A. Unless otherwise indicated, install shields (A-1 jacket) around insulated pipe and fittings exterior to building. Seal water and vapor tight at terminations.

B. Longitudinal overlap shall be at least 2" wide with vapor barrier sealant.

C. Secure jacketing with 3/4" wide 0.015" stainless steel or 3/4" wide 0.020" aluminum bands and wing seals on maximum 18" centers.

3.8 TYPE FR INSULATION (FIRE RESISTIVE DUCT WRAP)

A. Install Fire Resistive Duct Wrap system in accordance with manufacturer's instructions and referenced Standards.

B. Where duct is specified to have Type FR wrap, and other insulation is indicated in Ductwork/Equipment System Schedule in this Section, other insulation does not need to be provided in addition to Type FR wrap.

3.9 TYPE KG INSULATION (KITCHEN GREASE DUCT WRAP)

A. Install Fire Resistive Duct Wrap system in accordance with manufacturer's instructions and referenced Standards.

B. Where duct is specified to have Type KG wrap, and other insulation is indicated in Ductwork/Equipment System Schedule in this Section, other insulation does not need to be provided in addition to or Type KG wrap.

3.10 TYPE G INSULATION (CELLULAR GLASS)

A. Install cellular glass insulation system in strict accordance with manufacturer's installation instructions.

B. Chilled Water Piping (Interior):

1. Butter joints of insulation with Pittseal 727 or 444N Sealant. Apply insulation to pipe and fittings with joints tightly fitted and sealed full depth with joint sealant. Secure each length of insulation with 1" wide filament tape and stainless steel wire over tape. Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.
2. Finish with specified jacket, joints and laps sealed with fire rated adhesive. Finish elbows and fittings with white PC-79 polyester fabric coated with Pittcote 404.

C. Chilled Water Piping (Underground):

1. Apply insulation to pipe and fittings with joints tightly fitted. Hold each section of insulation in place with minimum 2 stainless steel wires.
2. Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.
3. Finish underground insulation with Type E-3 jacket and install in accordance with Pittsburgh Corning Bulletin FI-213, "Foamglass Insulation Systems for Underground Direct Burial Applications" and Product Data Sheets, FI-234, and FI-155, "Pittwrap SS Primer".

D. Steam and Steam Condensate Piping (with Type A-1 jackets):

1. Apply insulation to piping with all joints dry and tightly fitted without voids. Do not use glue on joints.
2. Secure insulation to piping with 1" wide, high tensile strength, fiber reinforced strapping tape similar to Scotch Brand Filament Tape and stainless steel wire over tape. Apply tape on equal spacing such that there are 2 rounds of tape per insulation section. Overlap tape minimum 50%.
3. Apply aluminum jackets over insulation.

a. Seal water and vapor tight at terminations.
b. Longitudinal overlap shall be at least 1/8" wide bead with metal jacketing sealant.
c. Secure jacketing with 3/4" wide 0.015" stainless steel or 3/4" wide 0.020" aluminum bands and wing seals on maximum 18" centers. Provide minimum of 2 bands per section.

E. Steam and Steam Condensate Piping (Underground Direct Buried)

1. Install insulation and jackets in accordance with Pittsburgh Corning Bulletin FI-213, Foamglas Insulation Systems for Underground Direct Burial Applications, and other appropriate Pittsburgh Corning product data sheets.

3.11 TYPE P INSULATION (POLYISOCYANURATE)

A. Install Type P insulation with specified insulation jacket in accordance with manufacturer's installation recommendations. Insulation shall be tightly butted and free of voids and gaps at joints. Use 3" wide tape at butt joints with minimum 1.25 times circumference wrapping. Apply insulation joint sealant in longitudinal and butt joints.

B. Install pre-fabricated tight fitting insulation pieces on fittings, elbows, tees and valves.

C. Insulation at fittings and valves shall be the same thickness as on pipe section.

D. Replace Type P insulation and jacket with Type R insulation of same thickness with Type P-1 jacket at penetration of fire rated walls and floor slabs where fire stopping system is required.

3.12 TYPE S INSULATION (POLYSTYRENE)

A. Pipe:

1. Use sectional insulation (semi-circular form) for pipe sizes 10" and smaller. Use segmental or sectional insulation for pipe sizes above 10".
2. Plain sectional insulation shall be applied so that end joints are broken by making one-half of first section 18" long and leaving other half 36" in length. Longitudinal joints shall be on top and bottom of pipe. Apply insulation with sealer such as Foster 30-45 Foam-seal or Childers CP-70 Chil Joint on joints of single layer and outer layer insulation with band placed approximately 3" or 4-1/2" (see band schedule) back from end joints. Do not cement insulation to pipe. Omit joint sealer from inner layer of double layer insulation.
3. Plain insulation lagging (blocks) for segmental insulation may be factory fabricated or beveled lagging assembled on job. Lags shall fit pipe snugly and maximum width of each lag shall be such as to leave not more than 1/8" void between pipe and joints of segments. Joints shall be broken by, starting with alternating 18" and 36" lags. Apply sealer and bands same as specified for plain sectional insulation.
4. Apply pipe insulation in double layer construction with joints staggered (2 layers at 1" thick each).

B. Fittings, Valves and Flanges:

1. Insulation at fittings shall not be of less thickness than insulation on adjacent piping. Fitting insulation (covers) shall be held together and applied with sealer. Insulation on welded fittings shall fit snugly to fitting contour and shall be applied in same manner and with same materials as specified for pipe.

2. Apply fitting insulation with sealer on joints and band insulation in place using not fewer than 2 bands on threaded fittings and 4 bands on flanged fitting.
3. Insulate threaded fittings before straight pipe is covered. Insulate flanged fittings after straight pipe is covered.

C. Band Material:

1. Secure single layer or outer layer insulation with stainless steel bands, 6" spacing for insulated outside diameter under 12" and 9" spacing for 12" and over.
2. Secure inner layer insulation with stainless steel bands 9" spacing.
3. Tighten bands with mechanical tightening tool and secure with 304 stainless steel wing type seals.

D. Vapor Barrier and Jacket:

1. Finish plain pipe insulation, fittings, valves and flanges with vapor barrier mastic.
2. After thoroughly dry, apply service jacket (Type P-1) and insulation shield jacket (Type A-1).

3.13 ENGINE EXHAUST PIPE INSULATION (OVER 1200°F)

A. Install engine exhaust pipe (4-layer system) in accordance with the following and as detailed on drawings.

B. 1st Layer:

1. Provide insulation spacer (stand-offs), tack-welded to exhaust pipe, to create specified air space and support for liner (2nd layer). Insulation spacer material shall be of same material as exhaust pipe and shall be minimum of 1/8” thick. Refer to details on drawings for quantity and location of insulation spacers.

C. 2nd Layer:

1. Liner shall be mechanically fastened to insulation spacers with stainless steel tap screws or bolts.

D. Insulation Support Tabs:

1. Provide insulation support tabs fastened through liner and into insulation spacers for support of 3rd layer and 4th layer of insulation system.
2. Support tabs shall be **[carbon steel] [Type 304 stainless steel]** and shall be segments of structural angle or fabricated bent plates in angle configuration, minimum 1/4”, with one leg being 1/2” short of outer jacket. The other leg shall be 2”. Support tabs shall not come in contact with outer jacket. Provide support tab at each insulation spacer around circumference of pipe at not more than 60”. Refer to details on drawings.

E. 3rd Layer:

1. Where multiple layers are required, stagger insulation joints and seams. Insulation shall rest on insulation support tabs and shall be secured in place with stainless steel bands.

F. 4th Layer:

1. Where multiple layers are required, stagger insulation joints and seams. Insulation shall rest on insulation support tabs and shall be secured in place with stainless steel bands.

G. Outer Jacket:

1. Finish system with specified outer jacket.

END OF SECTION 200700

SECTION 211314 - AUTOMATIC FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies materials, methods, and equipment to be used for automatic sprinkler system ~~**[standpipe system] [fire pump system]**~~ and related fire protection piping to 5 ft outside building.

B. Research indicates [there is no] ~~[there **is]**~~ documentation or indication that microbiologically influenced corrosion (MIC) exists in the area of the project.

C. NFPA 13's seismic requirements [are not] ~~[are]~~ part of this project.

D. This [is not] ~~**[is]**~~ a Factory Mutual Global (FMG) protected property.

E. As shown on drawings, system(s) shall consist of:

1. ~~XXX~~ **Two** automatic fire sprinkler zone(s) which consist of:
   a. ~~XXX~~ **2-** wet sprinkler zone(s)
   ~~b. XXX dry sprinkler zone(s)~~
   ~~c. XXX preaction sprinkler zone(s)~~
   ~~d. XXX deluge sprinkler zone(s)~~

F. Each wet pipe zone shall begin with:

1. Indicating-type floor control valve with supervisory switch

2. Check valve (required on combined standpipes)
3. Pressure gauge
4. Waterflow switch

5. Inspector's test and drain assembly ~~**[with integral pressure relief valve]**~~

G. Engineer of Record:

1. **[**Contractor shall be Engineer of Record. Contractor shall produce stamped and sealed installation drawings, which are also referred to as shop drawings in this Section, based on design criteria listed in this Section and drawings furnished by Engineer. Contract drawings show zone and main piping layouts of fire protection systems as it relates to architecture, structure, and mechanical/electrical systems.]

~~2. **[Affiliated Engineers is Engineer of Record for fire protection systems for this project. Contractor shall install fire protection systems as indicated on Contract Drawings and as indicated in this section. Nothing in this Section is to preclude Contractor from normal coordination with other trades to provide installation, which complies with Local Codes or NFPA standards.**~~
   ~~a. **Contractor shall provide detailed layout drawings based on submittal requirements by Local Authority. These layout drawings shall be based on**~~

~~**system as designed by Engineer of Record. Engineer of Record shall provide hydraulic calculations to be submitted to Local Authority.]**~~

H. All work shall be installed in conformance with the governing codes, regulations, local ordinances, and requirements of Authorities Having Jurisdiction. It shall be the responsibility of the Fire Protection Contractor to familiarize themselves with all governing codes and requirements and report any noncompliance of the plans or specifications to the Construction Manager/Engineer, prior to entering into the contract. These requirements are minimum criteria and no reductions permitted by Code shall be allowed without written permission of the Engineer.

I. No additional compensation shall be granted for work which must be changed as a result of the work not originally complying with codes and standards or not in accordance with the multiple trade coordination design criteria set forth in the contract documents.

J. If code or other requirements exceed provisions indicated in the Contract Documents, the Construction Manager/Engineer shall be notified in writing. Where the work indicated on the Contract Documents exceeds code requirements, the installation shall be done in accordance with the Contract Documents. Any work done contrary to these requirements shall be removed and replaced at the expense of the responsible Contractor.

K. Fire Protection Contractor shall become familiar with all details of the work, verify dimensions in the field, and advise the Construction Manager/Engineer of any discrepancy prior to entering into the contract.

L. Fire Protection Contractor shall file all drawings, pay all fees, and obtain all permits and certificates of inspection related to this work. Fire Protection Contractor shall arrange inspection with proper Authorities Having Jurisdiction and include all costs associated with said inspections in their bid.

1.2 RELATED WORK

A. Section 20 0000 – General Mechanical Requirements

~~B. **[Section 20 0513 – Motors]**~~

~~C. **[Section 20 0520 – Excavation and Backfill]**~~

~~D.~~**B. [**Section 20 0529 – Piping and Equipment Supporting Devices**]**

~~E. **[Section 20 0549 – Seismic Anchorage and Restraints]**~~

~~F.~~**C. [**Section 20 0553 – Mechanical Systems Identification~~]~~

~~G.~~**D. [**Section 20 0573 – Mechanical Systems Firestopping~~]~~

~~H. [Section 21 0000 – General Fire Suppression Requirements]~~

~~I. [Section 21 1114 – Exterior Fire Suppression Piping Systems]~~

~~J. [Section 21 2200 – Halocarbon Clean Agent Suppression System]~~

~~K. [Section 26 0593 – Electrical Systems Firestopping]~~

~~L. [Section 26 2913 – Enclosed Controllers and Contactors]~~

A. [Section 28 3113 – Fire Detection and Alarm Systems]

B. [Section 28 3116 – Multiplexed Fire Detection and Alarm Systems**]**

~~**1.3 [REFERENCE**~~

~~A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]**~~

~~**1.**~~**41.3 QUALITY ASSURANCE**

A. Codes and Standards:

1. This installation shall conform to the following:
   a. NFPA 13, Installation of Sprinkler Systems[, **2017~~3~~**~~XXX~~ Edition]
   ~~b. NFPA 14, Installation of Standpipe and Hose Systems[, XXX Edition]~~
   ~~c. NFPA 20, Installation of Stationary Pumps for Fire Protection[, XXX Edition]~~
   ~~d. [NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances, XXX Edition]~~
   ~~e.~~**b.** NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems[, ~~XXX~~ **2017~~4~~** Edition]
   ~~f.~~**c.** NFPA 30, Flammable and Combustible Liquids Code[, ~~XXX~~ **2017~~5~~** Edition]
   ~~g.~~**d.** NFPA 45, Fire Protection for Laboratories Using Chemicals[, ~~XXX~~ **2015~~7~~** Edition]
   ~~h.~~**e.** [NFPA 55, Compressed Gases and Cryogenic Fluids Code, ~~XXX~~ **2013~~7~~** Edition]
   ~~i.~~**f.** NFPA 72, National Fire Alarm [and Signaling] Code[, ~~XXX~~ **2017~~3~~** Edition]
   ~~j. [NFPA 101, Life Safety Code, XXX Edition]~~
   ~~k. [NFPA 214, Water-Cooling Towers, XXX Edition]~~
   ~~l. [NFPA 418, Standard for Heliports, XXX Edition]~~
   ~~m.~~**g.** [**2017** ~~International~~ **Florida** Building Code**, Sixth Edition** ~~(IBC), XXX **2017** Edition~~]
   ~~n.~~**h.** [**2017 Florida** ~~International~~ Fire **Prevention** Code ~~(IFC)~~, ~~XXX **2017**~~ **Sixth** Edition]
   ~~o.~~**i.** Local and State Building, Mechanical, and Fire Codes
   ~~p.~~**j.** Underwriters Laboratories (UL) Fire Protection Equipment Directory
   ~~q. **[Factory Mutual Global (FMG) Property Loss Prevention Data Sheets]**~~
   ~~r. **[Factory Mutual Research Corporation (FMRC) Approval Guide]**~~

B. Contractor Installation Program:

1. Provide licensed persons employed by sprinkler contractor to perform planning, calculations, layout, installation, and testing of fire protection systems. The following are acceptable:
   a. Licensed Professional Engineer
   b. National Institute for Certification of Engineering Technologies (NICET) Level IV
   c. Certified sprinkler designer

2. Provide journeyman sprinkler fitter(s) for installation and supervision.

3. Contractor shall be licensed in the State of ~~XXX~~ **Florida** for installation of fire protection systems.

4. Contractor shall submit pre-qualification evidence of at least 3 projects of comparable size successfully completed with their Bid.
5. Distortion or misrepresentation of qualification evidence may result in contract cessation.

C. Electrical Coordination

1. All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 contractors, except as specifically noted elsewhere in this specification.
2. Should any change in electrical equipment size, horsepower rating, or means of control be made to any motor or other electrical equipment after contracts are awarded, sprinkler contractor is to immediately notify Division 26 and Division 28 contractors of this change and pay any costs due to this change.
3. Division 26 contractors shall provide all power wiring and sprinkler contractor shall be responsible for providing all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
4. ~~[~~Sprinkler contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 contractors.~~]~~
5. Furnish wiring diagrams to Division 26 and Division 28 contractors for equipment and devices furnished by sprinkler contractor which have been indicated to be wired by Division 26 and Division 28 contractors.

~~1.5~~1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. All materials shall be stored in clean, dry space.

D. Promptly inspect shipments to insure material is undamaged and complies with Specifications. Storage and protection methods must allow inspection to verify products.

E. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling, and installation to prevent pipe-end damage and to eliminate dirt and construction debris from accumulating inside of pipe. Protect fittings and unions by storage inside or by durable, waterproof, aboveground packaging.

F. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.

G. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

~~1.6~~1.5 SUBMITTALS

A. Shop Drawings on Items Specified:

1. Pipe, Fittings, and Joints
2. Valves
3. Tamper Switches
4. Flow Switches

~~5. **[Pressure Switches]**~~
~~6.~~**5. [**Exterior Weatherproof Waterflow Alarm**]**
~~7.~~**6.** Sprinkler Heads
~~8.~~**7.** Sprinkler Head Cabinet
~~9. Preaction Valve and Accessories~~
~~10. Deluge Valve and Accessories~~
~~11. Dry Pipe Valve and Accessories~~
~~12.~~**8.** Hanger Assemblies
~~13.~~**9.** Pressure Gauges
~~14.~~**10.** Fire Department Connection (FDC)
~~15. Double Check Backflow Prevention Assembly (DCBP)~~

~~16. **[Reduced Pressure Zone Backflow Prevention Assembly (RPZ)]**~~

~~17. Fire Hose Cabinets (FHC)~~
~~18. Fire Valve Cabinets (FVC)~~
~~19.~~**11.** Fire Department Valves (FDV)

~~20. Fire Pump and Accessories~~
~~21. Fire Pump Test Connection~~
~~22. Fire Pump Controller **[with Automatic Transfer Switch] [without Automatic Transfer Switch]**~~
~~23. Jockey Pump and Accessories~~
~~24. Jockey Pump Controller~~

~~25.~~**12.** Drawings
~~26.~~**13. [**Hydraulic Calculations~~]~~
~~27. **[Seismic Restraint Detailing]**~~

~~B. **[Submit fire pump certified shop test curves showing pressure rating and rated horsepower to Engineer.]**~~

~~C.~~**B.** Submit Material Safety Data Sheet (MSDS) for corrosion inhibitive paint.

~~D.~~**C.** Include items listed in product section and additional items required to provide complete installation.

~~E.~~**D.** Indicate by red marking or arrow, items that are to be provided, where more than 1 item appears on manufacturer's catalog sheet.

~~F.~~**E.** Submit stamped and sealed drawings, product datasheets, ~~[~~hydraulic calculations~~]~~, ~~[and a signed copy of the Owner's certificate]~~ to local Fire Department, Engineer, and Owner's insurance representative prior to installation or fabrication of system components.

~~.[~~Submit stamped and sealed drawings, product data sheets, and hydraulic calculations to local Fire Department prior to installation or fabrication of system components.~~]~~

~~H.~~**G.** ~~[~~Include copy of Fire Department plan review letter in submission to Engineer.~~]~~

~~I.~~**H.** ~~[~~Prior to installation or fabrication of system components, submit layout drawings and equipment submittals to Engineer of Record.~~]~~

~~J.~~**I.** ~~[~~After review of layout drawings by Engineer of Record, submit drawings and calculations to Local Authority and Owner's Insurance Representative.~~]~~

~~K.~~**J.** Review of submittals does not relieve Contractor from coordinating installation of work with other trades, or from compliance with Codes and Standards.

~~L.~~**K.** At completion of acceptance tests:

1. Send copy of test log to Engineer
2. Send copy of Contractor's Material and Test Certificates ~~**[and fire pump test results]**~~ to:
   a. Engineer
   b. Owner
   c. Authority Having Jurisdiction

3. Provide Owner with following:
   a. Manufacturer's literature and instructions describing operation and maintenance of equipment and devices installed.
   b. Typewritten chart with identification and location of all access panels serving equipment and valves. Incorporate into Operation & Maintenance (O&M) manual.
   c. Typewritten valve schedule indicating valve number, fixture/equipment or areas served by each numbered valve. Incorporate into O&M manual.
   d. For additional O&M manual requirements, refer to Section 20 0000 – General Mechanical Requirements.
   ~~e. **[Current copy of NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems]**~~

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Equipment:

1. Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.
2. Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of same manufacturer.

3. Clean and cap pipe after fabrication and prior to placing pipe in building.
4. Mark pipe with tags that can be removed during installation so no permanent markings remain on unpainted pipe located in exposed areas.

~~5. Couplings shall be tees with capped outlets. These capped tees may be used in future to connect piping extensions to protect **[XXX]**.~~

B. Approval Guides:

1. Unless otherwise shown, products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory ~~**[[and] [or] approved in the latest Factory Mutual Research Corporation Approval Guide]**~~ for service intended.

2.2 PIPE

A. Below Ground:

1. Pipe: Ductile iron, Class 52, American Water Works Association (AWWA) C151, 150 psi working pressure, with standard cement mortar lining, AWWA C104, American National Standards Institute (ANSI) A21.4
2. Fittings: Ductile iron or grey iron, mechanical joint, cement mortar lined, Class 250, AWWA C110
3. Encasement: Polyethylene encasement, 8 mil thick, AWWA C105

B. Above Ground:

1. Carbon Steel, 2” and smaller:
   a. Pipe: Carbon steel pipe, Schedule ~~[10] [~~40**]**, American Society for Testing of Materials (ASTM) A795, A53, or A135
   b. Fittings:
      1). Malleable iron, threaded, Class 125, 175 psi Cold Water Pressure (CWP) rating, ANSI B16.3
      2). Cast iron, threaded, Class 125, 175 psi CWP rating, ANSI B16.4
      3). Cast iron, flanged, Class 125, 175 psi CWP rating, ANSI B16.1
      4). Carbon steel butt weld, ASTM A234 Grade WPB/American Society of Mechanical Engineers (ASME) B16.9, standard weight, seamless
      5). Ductile iron or malleable iron, ~~roll~~ **[**cut**]** grooved for mechanical coupling, ~~**1205 kPa(**~~175 psi ~~**)**~~ CWP rating, malleable iron conforming to ASTM A47.
         a). Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal
         b). Fitting, gasket, and coupling shall be furnished by same manufacturer.
   c. Joints:
      1). Threaded, tapered pipe threads, ANSI B1.20.1
      2). Flanged, cast iron, 175 psi CWP rating, ANSI B16.1, square head machine bolts with semi-finished hexagon nuts, ASTM A183, neoprene gasket
      3). Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.
      4). Mechanical:
         a). Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75
         b). Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N
         c). Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213
         d). ~~Dry systems gasket: Victaulic “FlushSeal” or equal~~
         e). Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.

2. Carbon Steel, larger than 2”:
   a. Pipe: Carbon steel pipe, Schedule ~~**[10] [**~~40**]**, ASTM A795, ASTM A53, or A135
   b. Fittings:

1). Carbon steel butt weld, ASTM A234 Grade WPB/ASME B16.9, Schedule 10, seamless

2). Ductile iron or malleable iron, ~~roll~~ **[**cut**]** grooved for mechanical coupling, 175 psi**)** CWP rating, malleable iron conforming to ASTM A47.

a). Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal

b). Fitting, gasket, and coupling shall be furnished by same manufacturer.

c. Joints:

1). Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.

2). Mechanical:

a). Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75

b). Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N

c). Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213

~~d). Dry systems gasket: Victaulic "FlushSeal" or equal~~

~~e).~~ **d).** Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.

~~3. Copper, **XXX** and **[Smaller][Larger]**:~~
~~a. Pipe: Copper tube, Type L, hard drawn, ASTM B88~~
~~b. Fittings:~~
~~1). Cast bronze, solder joint, pressure rated, ANSI B16.18~~
~~2). Wrought copper, solder joint, pressure rated ANSI B16.22~~
~~c. Joints:~~
~~1). Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32, flux ASTM B813~~
~~2). Brazed, silver solder, BCuP-5, AWS A5.8, **676°C(**1250°F**)** melting point minimum~~
~~d. Nipples: Red brass pipe, threaded~~
~~4. Galvanized Steel, **50 mm(**2"**)** and smaller:~~
~~a. Pipe: Galvanized steel pipe, Schedule **[10] [40]**, ASTM A795, ASTM A53, or A135~~
~~b. Fittings:~~
~~1). Malleable iron, threaded, galvanized coating, Class 125, ANSI B16.3~~
~~2). Forged steel, threaded, galvanized coating, ANSI 16.11~~
~~3). Ductile iron or malleable iron, roll **[cut]** grooved for mechanical coupling, **1205 kPa(**175 psi**)** CWP rating, malleable iron conforming to ASTM A47, **[standard ductile iron with standard painted coating] [hot dipped galvanized to ASTM A153 or zinc electroplating to ASTM B633]**~~

~~Regarding mechanical cut grooved versus roll grooved of galvanized pipe, when it is roll grooved, deformation occurs to the interior of galvanized pipe making it more susceptible to corrosion. In addition, the roll grooving process creates a dimpled ridge inside the pipe thus creating a valley to contain water & moisture which can accelerate the corrosion process. **NOTE** Schedule 10 pipe cannot be cut grooved or threaded.~~

~~a). Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal~~
~~b). Fitting, gasket, and coupling shall be furnished by same manufacturer.~~
~~c. Joints:~~

~~Manufacturers, such as Victaulic, have indicated that the alkyd coating on their mechanical couplings is a barrier against corrosion. This item usually comes up as a value engineering item or Request for Information (RFI) if you've specified galvanized couplings. Discuss with~~

~~project architect if galvanized pipe is visible to the public since the orange-colored, "alkyd" coating on the mechanical couplings and the silver-colored galvanized pipe presents a unique color scheme. See spec editor's notes in section of galvanized pipe larger than 50 mm(2").~~

~~1). Tapered pipe threads, ANSI B1.20.1~~

~~2). Mechanical:~~

~~a). Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75~~

~~b). Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N~~

~~c). Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213~~

~~d). Dry systems gasket: Victaulic "FlushSeal" or equal~~

~~e). Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.~~

~~5. Galvanized Steel, larger than **50 mm(**2"**)**:~~

~~a. Pipe: Galvanized steel pipe, Schedule **[10] [40]**, ASTM A795, ASTM A53, or A135~~

~~b. Fittings:~~

~~1). Cast iron, threaded, galvanized coating, Class 125, ANSI B16.4~~

~~2). Forged steel, threaded, galvanized coating, ANSI 16.11~~

~~Regarding mechanical cut grooved versus roll grooved of galvanized pipe, when it is roll grooved, deformation occurs to the interior of galvanized pipe making it more susceptible to corrosion. In addition, the roll grooving process creates a dimpled ridge inside the pipe thus creating a valley to contain water & moisture which can accelerate the corrosion process. **NOTE** Schedule 10 pipe cannot be cut grooved.~~

~~3). Ductile iron or malleable iron, roll **[cut]** grooved for mechanical coupling, **1205 kPa(**175 psi**)** CWP rating, malleable iron conforming to ASTM A47, **[standard ductile iron with standard painted coating] [hot dipped galvanized to ASTM A153 or zinc electroplating to ASTM B633]**~~

~~Manufacturers of fire protection couplings have confirmed that either their standard alkyd coated coupling or their galvanized coupling would be acceptable for use on galvanized pipe. Factors affecting the type to be provided are the higher cost of galvanized couplings versus aesthetics of having bright orange couplings on bright metallic galvanized pipe. The project budget along with owner and architect expectations must be considered. Select one of the two choices.~~

~~a). Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal~~

~~b). Fitting, gasket, and coupling shall be furnished by same manufacturer.~~

~~c. Joints:~~

~~1). Tapered pipe threads, ANSI B1.20.1~~

~~2). Mechanical:~~

~~a). Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic Style 75~~

~~b). Rigid mechanical, ductile iron, ASTM A-536, equal to Victaulic Style 009N~~

~~c). Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213~~

~~d). Dry systems gasket: Victaulic "FlushSeal" or equal~~

~~e). Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.~~

~~6. Stainless Steel, **50 mm(**2"**)** and smaller:~~

~~a. Pipe: Type 316, Schedule 40 stainless steel pipe, seamless, ASTM A312.~~

~~b. Fittings:~~

~~1). Stainless steel type 316, threaded, Class 125, **1205 kPa(**175 psi**)** Cold Water Pressure (CWP) rating, ASTM A182~~

~~2). Stainless steel type 316, flanged, Class 150, **1205 kPa(**175 psi**)** CWP rating, ANSI B16.5~~

~~3). Stainless steel type 316, Schedule 40 wrought fittings, socket or butt weld pattern, ASTM A312, ASME B16.9~~

~~c. Joints:~~
~~1). Threaded, tapered pipe threads, ANSI B1.20.1~~
~~2). Flanged, stainless steel, **1205 kPa(**175 psi**)** CWP rating, ANSI B16.5, square head machine bolts with semi-finished hexagon nuts, ASTM A182, neoprene gasket~~
~~3). Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done. Welding of stainless steel pipe and fittings shall be done in accordance with NFPA 13 and manufacturer's installation instructions.~~
~~7. Stainless Steel, larger than **50 mm(**2")**:~~
~~a. Pipe: Type 316, Schedule 40 stainless steel pipe, seamless, ASTM A312.~~
~~b. Fittings:~~
~~1). Type 316 stainless steel, threaded, Class 125, **1205 kPa(**175 psi**)** Cold Water Pressure (CWP) rating, ASTM A182~~
~~2). Type 316 stainless steel, flanged, Class 150, **1205 kPa(**175 psi**)** CWP rating, ANSI B16.5~~
~~3). Type 316 stainless steel, roll **[cut]** grooved for mechanical coupling, minimum 600 psi CWP rating, conforming to ASTM A351, A743, and A744.~~
~~a). Acceptable manufacturers: Anvil Gruvlok, Smith-Cooper International, Victaulic, or equal~~
~~b). Fitting, gasket, and coupling shall be furnished by same manufacturer.~~
~~c. Joints:~~
~~1). Threaded, tapered pipe threads, ANSI B1.20.1~~
~~2). Flanged, stainless steel, **1205 kPa(**175 psi**)** CWP rating, ANSI B16.5, square head machine bolts with semi-finished hexagon nuts, ASTM A182, neoprene gasket~~
~~3). Mechanical:~~
~~a). Rigid mechanical, type 316 stainless steel, ASTM A351, equal to Victaulic Style 489~~
~~Edit or delete the following item as necessary. Be aware that CPVC sprinkler pipe has many limitations identified by its Listing and FM Approval along with limitations identified in NFPA 13. Use of CPVC sprinkler pipe on the project is an item that must be discussed with the Owner, insurance carrier, architect, and code authorities.~~
~~8. **[Chlorinated Polyvinyl Chloride (CPVC):**~~
~~a. **Pipe: CPVC fire sprinkler pipe:**~~
~~1). **Shall be UL listed for wet pipe sprinkler systems.**~~
~~2). **Shall meet or exceed requirements of ASTM F442 in standard dimension ration (SDR) 13.5. Compound shall meet cell class 23447-B as defined by ASTM D1784.**~~
~~3). **Shall be certified NSF for use with potable water.**~~
~~b. **Fittings:**~~
~~1). **Shall be UL Listed for wet pipe sprinkler systems.**~~
~~2). **Shall meet or exceed requirements of ASTM F438 (Schedule 40 socket) and ASTM F439 (Schedule 80 socket).**~~
~~c. **Joints:**~~
~~1). **All socket type joints shall be made up employing solvent cements that meet or exceed requirements of ASTM F493. Solvent cement shall be listed by NSF for use with potable water, and approved by manufacturer.**~~
~~2). **Threaded:**~~
~~a). **Shall meet or exceed requirements of ASTM F437 (Schedule 80 threaded).]**~~
~~Edit or delete following item as necessary. Use following option where applicable and acceptable to the parties involved with this project. Item should be discussed with Owner and Authority Having Jurisdiction (AHJs) to ensure acceptability. UL 2443 is titled "Flexible Sprinkler Hose with Fittings for Fire Protection Service". UL 1474 which is titled as: "Adjustable Drop Nipples for Sprinkler Systems" is NOT the same.~~
~~9. **[Flexible sprinkler hose fittings for fire protection service shall be manufactured by FlexHead Industries, Inc., 56 Lowland Street, Holliston, MA 01746; Telephone: (800) 829-6975. No substitutions allowed. Product shall be FMRC Approved for its**~~

~~**intended use pursuant to FM 1637 – Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings. Product shall be UL Listed for its intended use pursuant to UL 2443 – Standard for Flexible Sprinkler Hose with Fittings for Fire Protection Service. For seismic projects, product shall be seismically qualified for use pursuant to ICC–ES AC-156 – Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems. Provide high pressure fittings where pressures exceed 1205 kPa(**175 psi**) water working pressure. Model numbers on high pressure fittings must include the "H" suffix.**~~

~~a. **FlexHead Flexible Hose Assemblies and End Fittings:**~~

~~1). **Composition: 100% Type 304 Stainless Steel**~~

~~2). **Shall be fully welded non-mechanical fittings, braided, leak-tested with minimum 25 mm(**1"**) true-bore internal corrugated hose diameter**~~

~~3). **Straight Hose Assembly Lengths: 0.6 m(**2 ft**) length, Model #2024; 0.9 m(**3 ft**) length, Model #2036; 1.2 m(**4 ft**) length, Model #2048; 1.5 m(**5 ft**) length, Model #2060; 1.8 m(**6 ft**) length, Model #2072**~~

~~4). **Elbow Hose Assembly lengths: 0.6 m(**2 ft**) length, Model 2024E; 0.9 m(**3 ft**) length, Model #2036E; 1.2 m(**4 ft**) length, Model #2048E; 1.5 m(**5 ft**) length, Model #2060E; 1.8 m(**6 ft**) length, Model #2072E**~~

~~b. **FlexHead Ceiling Bracket:**~~

~~1). **Composition: Type G90 Galvanized Steel**~~

~~2). **Type: Direct attachment type, having integrated snap-on clip ends positively attached to the ceiling using tamper-resistant screws**~~

~~3). **Flexible hose attachment: Removable hub type with set screw]**~~

~~10. Provide metal pipe's exposed threads with corrosion inhibitive paint, equal to Rust-Oleum.~~

~~11. Provide pipe identification system with flow directional arrows on fire protection pipe. For additional information about pipe identification, refer to Section 20 0553 – Mechanical Systems Identification.~~

~~12. Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) are not allowed on either new or existing sprinkler systems.~~

~~13. Adjustable drop nipples are not allowed on either new or existing sprinkler systems.~~

~~Verify locations of and amount of deflection occurring at the building's expansion joint. Refer to manufacturer's product data sheet to determine which type assembly is best suited for your project.~~

~~If your project has pressures greater than 1205 kPa(175 psi), be aware that the Tri-Flex Loop and FireLoop may only be Listed at 2070 kPa(300 psi) for pipe sizes that are 80 mm(3") in diameter or less. For larger pipe such as 100 mm(4"), 150 mm(6") and 203 mm(8"), with pressures greater than 1205 kPa(175 psi), you might need to specify standard swing joints with the couplings, elbows and pipe nipples.~~

~~If your building does not have expansion joints or deflection is insignificant, you can delete the following. Ensure you document your research.~~

~~14. Expansion joints:~~

~~a. Provide **[AnvilStar Tri-Flex Loop] [MetraFlex FireLoop] [swing joints with flexible grooved couplings, pipe nipples, and grooved elbows]** installed per manufacturer's installation instructions.~~

~~b. Refer to structural drawings for location of expansion joints.~~

~~c. Provide high pressure expansion joints and mechanical couplings where pressures exceed **1205 kPa(**175 psi**)** water working pressure.~~

~~15. Shop welded joints:~~

~~a.~~**3.** ~~Welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.~~

2.3 VALVES

A. Gate Valve:

1. Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
2. Outside screw and yoke (OS&Y) gate valve, bronze body and trim or cast iron body bronze mounted and rated for 175 psi, non-shock water working pressure, Nibco F-607-OTS or equal.
3. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.

B. Vertical Post Indicator Valve:

1. Acceptable manufacturers: Kennedy, Mueller, Nibco, Stockham, Victaulic, or equal
2. Non-rising stem (NRS) gate valve, ductile iron body, resilient wedge, epoxy coated interior and exterior, includes indicator post flange and flange screw, rated for 300 psinon-shock cold working pressure, Nibco F-609-RWS or equal.
3. Cast iron post with lockable lever operator for use with non-rising stem gate valve, 1" square valve stem extension rod, UV-stabilized Lexan window containing cast aluminum signage reading "OPEN" and "SHUT", Kennedy Model 2495A, Nibco NIP-1AJ, Victaulic Series 774, or equal.

~~C. Wall Post Indicator Valve:~~

~~1. Acceptable manufacturers: Kennedy, Mueller, Nibco, Stockham, Victaulic, or equal~~
~~2. Non-rising stem (NRS) gate valve, ductile iron body, resilient wedge, epoxy coated interior and exterior, includes indicator post flange and flange screw, rated for 300 psinon-shock cold working pressure, Nibco F-609-RWS or equal.~~
~~3. Wall post indicator for use with non-rising stem (NRS) gate valve, cast iron body, steel operating rod, Lexan-UV stabilized or polycarbonate window containing cast aluminum signage reading "OPEN" and "SHUT", Kennedy Model 641, Nibco Model NIP-3AJ, Victaulic Series 773, or equal.~~

~~D.~~**C.** Check Valve:

1. Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal
2. Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal, Tyco Fire Products CV-1F, Viking Model G-1, or equal.
3. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.

~~E.~~**D.** Check Valve (Anti-Water-Hammer type)

1. Acceptable manufacturers: Anvil Gruvlok, Reliable, Tyco Fire Products, Victaulic, Viking, or equal
2. Ductile iron conforming to ASTM A536, Grade 65-45-12, rust inhibiting coating, sizes 2" to 5" consisting of stainless steel clapper conforming to ASTM A-167 and for sizes 6" to 8" consisting of ductile iron clapper conforming to ASTM A-536, Anvil Gruvlok Series 78FP or equal.
3. Provide high pressure valves and fittings where pressures exceed 175 psi water working pressure.

~~F.~~**E.** Ball Valve:

1. Acceptable manufacturers: Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic, or equal
2. Provide high pressure valves and fittings when pressures exceed 175 psi water working pressure.

~~G.~~**F.** Butterfly Valve:

1. Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Tyco Fire Products, Victaulic, or equal
2. Milwaukee Valve Co. Series BB for valve sizes 1” to 2-1/2” or equal.
3. Kennedy Valve Co. Fig. G300 for sizes 2-1/2” to 6”, Victaulic FireLock Series 705 for valve sizes 2-1/2” to 8”, or equal
4. Provide high pressure valves and fittings when pressures exceed 175 psi~~)~~ water working pressure.

~~H. Double Check Backflow Prevention Assembly (DCBP):~~

~~1. Acceptable manufacturers: Ames, Apollo, Cla-Val, Febco, Watts, or equal~~
~~2. Weighted clapper double check valve assembly including 2 supervised OS&Y gate valves~~
~~3. Assembly shall be double check valve assembly for cross connection devices.~~
~~4. Certified in accordance with ASSE 1015 and AWWA C510-97~~
~~5. Double check valve shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.~~
~~6. Provide high pressure DCBP assembly and fittings when pressures exceed **1205 kPa(**175 psi**).**~~

~~I. **[Reduced Pressure Zone Backflow Prevention Assembly (RPZ):**~~

~~1. **Acceptable manufacturers: Ames, Apollo, Cla-Val, Febco, Watts, or equal**~~
~~2. **Assembly shall consist of 2 independently operating, spring loaded cam-check valves and include 2 supervised OS&Y gate valves.**~~
~~3. **Assembly shall have a hydraulically operated differential pressure relief valve located between and below cam-checks.**~~
~~4. **Certified in accordance with ASSE 1013 and AWWA C511-97**~~
~~5. **Assembly shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.**~~
~~6. **Provide high pressure RPZ assembly and fittings when pressures exceed 1205 kPa(**175 psi**).]**~~

~~J.~~**G.** Test and Drain Valves:

1. Acceptable manufacturers: AGF, Victaulic, or equal
2. AGF TESTanDRAIN, Victaulic Style 720 TestMaster II, or equal
3. ~~**[Test and drain valve shall include integral pressure relief valve. Pressure relief valve shall be set to operate at 1205 kPa(**175 psi**) or 70 kPa(**10 psi**) in excess of the maximum system pressure, whichever is greater.]**~~
4. ~~Provide high pressure valves and fittings where pressures exceed **1205 kPa(**175 psi**)** water working pressure.~~

~~K.~~**H.** Drain Valves:

1. Acceptable manufacturers: Kennedy, Nibco, or equal
2. Thread-in bonnet bronze globe valves, rated to 175 psi non-shock water working pressure, Nibco KT-65 Series for valve sizes 1/2" to 1", KT-211 Series 1-1/4" to 2", or equal.
3. Provide high pressure valves and fittings when pressures exceed 175 psi**)** water working pressure.

~~L. Pressure Regulating Valves:~~

1. ~~Acceptable manufacturers: Croker, Elkhart Brass, Potter-Roemer, or equal~~
2. ~~Valve shall be able to regulate inlet pressure up to **2750 kPa(**400 psi**)**, brass body with brass and stainless steel internal parts, field adjustable indicating scale, non-rising stem, red handwheel, tamper-proof monitor switch adapter, Potter-Roemer Model 4036-MSA or equal for in-line applications and Model 4021-MSA or equal for end-of-line applications.~~

~~M.~~**I.** Fire Department Valve (FDV):

1. Acceptable manufacturers: Croker, Elkhart Brass, Potter-Roemer, or equal
2. Fire Department valve shall be ~~**65 mm(**~~2-1/2"~~**)**~~ angle valve, cast brass body, ~~[~~polished brass~~]~~ ~~[rough brass] [polished chrome plated]~~ finish, equal to Potter-Roemer Model 4065. Valve cap for ~~**65 mm(**~~2-1/2"~~**)**~~ valve shall be ~~**[65 mm(**2-1/2"**) x 40 mm(**1-1/2"**) hose adapter reducer, Potter-Roemer Model 2810 or equal, with 40 mm(**1-1/2"**) cap with chain, Potter-Roemer Model 4615 or equal] [65 mm(**~~2-1/2"~~**)**~~ cap with chain, Potter-Roemer Model 4625 or equal~~**]**~~. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.

~~N. Fire Department Valve (FDV - Pressure Regulating type)~~

1. ~~Acceptable manufacturers: Croker, Elkhart Brass, Potter-Roemer, or equal~~
2. ~~Fire Department valve shall be **65 mm(**2-1/2"**)** angle valve, able to regulate inlet pressure up to **2750 kPa(**400 psi**)**, cast brass body with brass and stainless steel internal parts, indicating scale, non-rising stem, red handwheel, **[tamper-proof monitor switch adapter]**. Finish shall be **[polished brass] [rough brass] [polished chrome plated]**. Valve shall be equal to Potter-Roemer Model 4023 for end-of-line applications. Valve cap for **65 mm(**2-1/2"**)** valve shall be **[65 mm(**2-1/2"**) x 40 mm(**1-1/2"**) hose adapter reducer, Potter-Roemer Model 2810 or equal, with 40 mm(**1-1/2"**) cap with chain, Potter-Roemer Model 4615 or equal] [65 mm(**2-1/2"**) cap with chain, Potter-Roemer Model 4625 or equal]**. Cap and chain shall match finish of valve body. Threads shall match Fire Department Standards.~~

~~O. Riser Manifold:~~

1. ~~Acceptable manufacturers: Tyco Fire Products, Victaulic, Viking, or equal~~
2. ~~Ductile iron or fabricated steel pipe body; threaded or grooved connections; rated to **1205 kPa(**175 psi**)** non-shock water working pressure; includes test and drain valve **[with integral pressure relief valve kit]**, flow switch **[with] [without]** optional cover tamper kit, and pressure gauge; Tyco Fire Products Model 513 or equal.~~
3. ~~Provide high pressure valves and fittings when pressures exceed **1205 kPa(**175 psi**)** water working pressure.~~

~~P. Air Release Valve:~~

1. ~~Acceptable manufacturers: Engineered Corrosion Solutions, Potter Electric Signal Co., or equal~~

2. ~~Automatic float type air vent, ball valve with tamper switch, Y-type strainer, and single set of normally closed dry contacts rated 24VAC/DC at 2 Amps, UL 2573 Listed, FM Approved "Automatic Air Release Valve for Sprinkler Systems", rated to **1205 kPa(**175 psi**)** non-shock water working pressure, Potter Electric Signal Co. Model PAAR-B or equal.~~
3. ~~Air release valve shall be installed in an accessible location to permit operation, maintenance, and visual inspection of the status of the valve.~~
4. ~~Provide high pressure valves and fittings when pressures exceed **1205 kPa(**175 psi**)** water working pressure.~~

~~Q.~~ Provide identification sign (enamel on metal) for valves per NFPA requirements. ~~**[For additional information, refer to Section 20 0553 – Mechanical Systems Identification.]**~~

~~R.~~**J.** Valves in galvanized piping shall be bronze.

~~2.4 PREACTION VALVE AND ACCESSORIES~~

~~A. Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal~~

~~B. Each preaction sprinkler system shall be independent of each other and shall contain separate valves and accessories.~~

~~C. Provide high pressure preaction valve assembly where pressures exceed **1205 kPa(**175 psi**)** water working pressure.~~

~~D. Preaction system shall be **[single] [double]** interlocked, supervised system.~~

~~E. Piping system shall be pneumatically pressurized for supervisory purposes.~~

~~F. Valve shall be self-closing design and will not require disassembly for resetting.~~

~~G. Each system shall include:~~

1. ~~Preaction valve trim~~
2. ~~Pressure operated relief valve~~
3. ~~Alarm pressure switch~~
4. ~~Supply control valve~~
5. ~~Soft seat check valve~~
6. ~~Air supervisory pressure switch~~
7. ~~Air supply control valve~~
8. ~~Release solenoid valve~~
9. ~~Maintenance air compressor~~
10. ~~Emergency release~~

11. ~~Microprocessor-Controlled Release Control panel with compatible Fire Detection System~~
    a. ~~Acceptable Manufacturers: **XXX**~~

12. ~~**[Sequential] [Cross zoned]** with **[photoelectric and ionization smoke detectors] [rate-of-rise and XXX°C(**°F**) fixed temperature heat detectors] [Air-aspirating smoke detection] [UV detectors] [IR detectors] [Multi-criteria detectors]**~~

~~H. Preaction Control Panel:~~

1. Control panel shall communicate and be coordinated with the main Fire Alarm System.

2. Contacts shall be available so that the main Fire Alarm Control Panel can monitor the preaction system releasing panel for alarm, trouble, and supervisory signals.
3. Provide additional contacts as needed for additional auxiliary functions. **[Additional contacts required for this project will include the operation of XXX, XXX.]**

4. Standby power battery: Minimum battery capacity shall be for **[4] [24] [90]** h standby mode plus **[5] [15]** minutes alarm mode. Battery derating factor shall be 1.2.
5. Shall include automatic battery charger

I. Provide detection system to operate preaction sprinkler system. Detection system shall be installed per **[28 3113 – Fire Detection and Alarm Systems] [Section 28 3116 – Multiplexed Fire Detection and Alarm Systems]** and as indicated on **[electrical drawings] [fire protection drawings]**.

J. Provide maintenance air compressor.

1. UL 1450 Listed maintenance air compressor shall have capacity to refill system within 30 minutes.
2. Compressor shall be floor mounted **[with vibration isolation springs, Mason Industries Type SLFH, sized for minimum 25 mm(**1.0”**) static deflection]**.

2.5 DELUGE VALVES AND ACCESSORIES

A. Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal

B. Deluge system shall be activated by cross-zoned detection system.

C. Provide high pressure deluge pipe valve assembly where pressures exceed **1205 kPa(**175 psi**)** working water pressure.

D. Deluge system shall consist of **[closed sprinklers] [open sprinklers]**.

E. Deluge water curtain system shall be simple deluge application using solenoid valve release.

F. System release valve shall be normally closed when deenergized and open when energized by 24 V DC power from fire alarm system.

G. Open circuits in detection system, or loss of power shall not have effect on operating solenoid.

H. System shall include the following:

1. Deluge valve
2. Valve trim piping and components
3. Emergency release
4. Pressure operated relief valve
5. Solenoid valve
6. Microprocessor-Controlled Release Control panel with compatible fire detection
   a. Acceptable manufacturers: **XXX**

7. ~~**[Photoelectric and ionization smoke detectors] [Rate-of-rise and XXX°C(**°F**) fixed temperature heat detectors] [UV detectors] [IR detectors] [Multi-criteria detectors]**~~
8. ~~**[Sequential, counting logic (addressable systems)] [Cross-zoning (conventional systems)]** is **[not]** a requirement for this project.~~

I. ~~Deluge System Releasing Control Panel:~~

1. ~~Releasing control panel shall communicate and be coordinated with main Fire Alarm System.~~
2. ~~Contacts shall be available so that main Fire Alarm Control Panel can monitor deluge system releasing panel for alarm, trouble and supervisory signals.~~

3. ~~Provide additional contacts as needed for additional auxiliary functions. **[Additional contacts required for this project will include operation of XXX, XXX.]**~~

4. ~~Standby power battery: Minimum battery capacity shall be for **[4] [24] [90]** h standby mode plus **[5] [15]** min alarm mode. Battery derating factor shall be 1.2.~~
5. ~~Automatic battery charger~~

J. ~~Provide detection system to operate deluge sprinkler. Detection system shall be installed per **[Section 28 3113 – Fire Detection and Alarm Systems] [Section 28 3116 – Multiplexed Fire Detection and Alarm Systems]** and as indicated on **[electrical drawings] [fire protection drawings]**.~~

~~2.6 ALARM CHECK VALVE~~

A. ~~Alarm check valve shall be check valve assembly with retard chamber.~~

B. ~~Include gauges, waterflow alarm pressure switch, drain valve, bypass piping and valves.~~

C. ~~Alarm check valve shall be capable of transmitting signal when water flow equals or exceeds discharge of single head.~~

D. ~~**[Waterflow alarm bell] [**Waterflow alarm horn/strobe] **[Water motor-operated alarm]** shall be included with alarm valve. Waterflow alarm shall be compatible with building's fire alarm system.~~

~~2.7 DRY PIPE VALVE~~

A. ~~Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal~~

B. ~~Dry pipe valve shall assembly shall include accelerator.~~

C. ~~Include standard trimmings, such as gauges, drain valve, test valve, air connection, and air supervisory pressure switch.~~

D. ~~Provide maintenance air compressor.~~

1. ~~UL 1450 Listed maintenance air compressor shall have capacity to refill system within 30 minutes.~~

~~2. Compressor shall be floor mounted with **[vibration isolation springs, Mason Industries Type SLFH, sized for minimum 25 mm(**1.0”**) static deflection.]**~~

~~E. **[Waterflow alarm bell] [Waterflow alarm horn/strobe] [Water motor-operated alarm]** shall be included with dry pipe valve. Waterflow alarm shall be compatible with building’s fire alarm system.~~

~~2.8~~2.4 TAMPER SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of SPDT (Form C) contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide **[**with~~] **[without]**~~ optional cover tamper kit. For areas identified as hazardous locations, provide “EX” Model. Potter Electric Signal Co. OSY series or equal.

C. Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide **[**with~~] **[without]**~~ optional cover tamper kit. For areas identified as hazardous locations, provide “EX” Model. Potter Electric Signal Co. PIBV series or equal.

D. Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.

E. Unit shall be compatible with building’s fire alarm system.

~~2.9~~2.5 FLOW SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Vane type waterflow switch for use in wet sprinkler systems, minimum ~~**2070 kPa(**~~300 psi~~**)**~~ service pressure rating, ~~**0.63 L/s(**~~10 gpm~~**)**~~ minimal flow rate to activate alarm, and 2 sets of SPDT (Form C) contacts. Provide **[**with~~**] [without]**~~ optional cover tamper kit. Potter Electric Signal Co. VS series or equal.

C. Unit shall be compatible with building’s fire alarm system.

~~2.10~~2.6 WATERFLOW ALARM PRESSURE SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal

B. Pressure actuated switch for use in dry sprinkler systems, ~~**2070 kPa(**~~300 psi~~**)**~~ service pressure rating, adjustable between ~~**27-100 kPa(**~~4-15 psi~~**)**~~, 2 sets of SPDT (Form C) contacts rated at 2 amps at 30 VDC and 10.1 amps at 125/250 VAC. Provide **[**with~~**] [without]**~~ optional cover tamper kit. Potter Electric Signal Co. PS series or equal.

C. Unit shall be compatible with building’s fire alarm system.

~~**2.11 AIR SUPERVISORY PRESSURE SWITCH**~~

~~A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, or equal~~

~~B. Pressure actuated switch to detect a decrease from normal system pressure in dry sprinkler systems, **2070 kPa(**300 psi**)** service pressure rating, set to operate at a pressure decrease of **70 kPa(**10 psi**)** at **210 kPa(**30 psi**)**, 2 sets of SPDT (Form C) contacts rated at 2 Amps at 30 VDC and 10.1 Amps at 125/250 VAC. Provide **[with] [without]** optional cover tamper kit. Potter Electric Signal Co. PS series or equal.~~

~~C. Unit shall be compatible with building's fire alarm system.~~

~~2.12~~2.7 WATERFLOW ALARM (EXTERIOR OF BUILDING)

A. Acceptable manufacturers: Cooper Wheelock, Potter Electric Signal Co., or equal

B. Basis of Design:

1. ~~[~~Cooper Wheelock ASWP series, ~~[~~red~~] [white]~~ finish with compatible weatherproof backbox. Audible strobe shall comply with UL 1638 – Standard for Visual Signaling Appliances, and UL 464 – Audible Signal Appliances~~.] **[Potter Electric Signal Co. [150 mm(**6”**)] [200 mm(**8”**)] [250 mm(**10”**)] diameter bell with compatible weatherproof backbox. Electric bell shall comply with UL 464 – Audible Signal Appliances.]**~~

C. Device shall be compatible with building's fire alarm system.

D. If required by code official, provide approved signage per NFPA 13.

~~2.13~~2.8 SPRINKLER HEAD

A. Manufacturers:

1. Unless otherwise noted below, shall be manufactured by Reliable, Tyco Fire Products, Viking, or equal.

B. Automatic, having temperature and pressure rating suitable for location

C. Light Hazard occupancies shall utilize quick-response type sprinkler heads.

D. Architect will review deviations from specified styles for approval prior to installation.

E. Provide the following type of sprinkler head ~~[~~where shown on drawings~~]~~.

1. Type ~~XXX~~**A**: Unfinished areas such as mechanical spaces~~, **[central utility plant]**, **[tunnels], [XXX]**~~.
   a. Standard Coverage, Brass Upright or Pendent, ordinary temperature class (~~**[XXX]º155C(**~~°F~~**)**~~), Tyco Fire Products Model TY-FRB, Viking Microfast, or equal.
   ~~b. Extended Coverage, Brass Upright or Pendent, large orifice, ordinary temperature class **([XXX]ºC(**°F**)**), Tyco Fire Products Model EC-11/14, Viking ECOH-ELO, or equal, designed and installed per its listing **[and FMRC approval]**.~~

2. Type ~~XXX~~**B**: In areas with ceilings.
   a. Standard Coverage, Concealed Pendent, ordinary temperature class (~~**[XXX155]°C(**~~°F~~**)**~~), Tyco Fire Products Model RFII, Viking Mirage, or equal adjustable sprinkler with ~~**59°C(**~~139°F~~**)**~~ temperature class cover plate, mounted flush with ceiling. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer).
   ~~b. Standard Coverage, Semi-Recessed, ordinary temperature class (**[XXX]°C(**°F**)**), Tyco Fire Products TY-FRB, Viking Microfast, or equal. Sprinkler and escutcheon finish shall be standard **[chrome] [bright white] [black] [XXX]**.~~

3. Type ~~[XXX]~~**C**: In areas where ceiling conditions do not permit installation of pendent head or finished area where sidewall head provides better coverage of hazard.
   a. Standard Coverage, standard ~~[chrome] [~~bright white~~]~~ finish, ordinary temperature class (**155~~[XXX]°C(**~~°F~~**)**~~), Tyco Fire Products Model TY-FRB, Viking Microfast horizontal (HSW) or vertical (VSW) sidewall with Viking Microfast Model F-1 adjustable escutcheon, or equal.
   ~~b. Extended Coverage, standard **[chrome] [bright white]** finish, ordinary temperature class (**[XXX]°C(**°F**)**), Tyco Fire Products Model TY-FRB or equal designed and installed per its listing **[and FM approval]**.~~

~~4. Type **[XXX]**: In patient rooms with inaccessible ceilings.~~
   ~~a. Standard Coverage, standard **[chrome] [bright white]** finish, ordinary temperature class (**[XXX]°C(**°F**)**), horizontal (HSW) sidewall, Tyco Fire Products Model TY-FRB or equal design and installed per its listing **[and FMRC approval]**.~~
   ~~b. Extended Coverage, standard **[chrome] [bright white]** finish, ordinary temperature class (**[XXX]°C(**°F**)**), horizontal (HSW) sidewall, Tyco Fire Products Model TY-FRB or equal designed and installed per its listing **[and FMRC approval]**.~~

~~5.~~**4.** Type **D~~XXX~~**: In **exterior soffits**~~walk-in coolers, freezers~~, and areas subject to temperatures at or below **4°C(**40°F**)**.
   a. Standard Coverage, **Quick response, concealed pendant**~~standard chrome finish **[dry pendent] [dry horizontal sidewall]**~~, ~~intermediate~~ **ordinary** temperature class (~~**[165XXX]°C(**~~°F~~**)**~~), **White cover plate 139°F,** ~~adjustable recessed chrome escutcheon~~, Tyco Fire Products Model DS-~~1~~**C** or equal.
   ~~b. Provide compatible wire cage sprinkler head guard where sprinklers are subject to impact damage.~~

~~6. Type **XXX**: Deluge water curtain systems.~~
   ~~a. Standard Coverage, Polished Chrome Pendent, **[closed] [open]** sprinkler with open type, 2-piece adjustable escutcheon, Tyco Fire Products Model TY-FRB or equal with compatible escutcheon.~~

~~7. Type **XXX**: In Vivarium.~~
   ~~a. Standard Coverage, Semi-Recessed **[polyester coated] [stainless steel]** head and escutcheon, ordinary temperature class (**[XXX]°C(**°F**)**), Viking or equal.~~
   ~~b. Standard Coverage, Concealed Pendent head, ordinary temperature class (**[XXX]°C(**°F**)**), Viking Mirage with **57°C(**135°F**)** temperature class cover plate, mounted flush with ceiling, or equal. Concealed pendent sprinkler shall be provided with Cleanroom Cover Assembly. Cover plate shall match ceiling color and shall be factory-painted (i.e. by manufacturer).~~

~~8.~~**5.** Type ~~XXX~~**E~~D~~**: Inside steam dam of cage wash areas and autoclaves.

a. Standard Coverage, Pendent with polyester coating, ~~[intermediate] [~~high~~]~~ temperature class (**286~~[XXX]°C(~~**°F~~)~~), Tyco Fire Products Model TY-FRB, Viking Microfast, or equal.

6. Type FE: In skylights.

a. **Standard Coverage, Concealed Pendent, ordinary temperature class 200°F), Tyco Fire Products Model RFII, Viking Mirage, or equal adjustable sprinkler with 165°F temperature class cover plate, mounted flush with ceiling. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer)**

~~9. Type **XXX**: In cage wash areas.~~

~~a. Standard Coverage, Pendent with polyester coating, **[intermediate] [high]** temperature class (**[XXX]°C(**°F**)**), Tyco Fire Products Model TY-FRB, Viking Microfast, or equal.~~

~~10. Type **XXX**: In unfinished areas where conditions do not permit installation of upright or pendent head.~~

~~a. Standard Coverage, Brass Sidewall, ordinary temperature class (**[XXX]°C(**°F**)**), Tyco Fire Products Model TY-FRB, Viking Microfast horizontal (HSW) or vertical (VSW) sidewall or equal.~~

~~11. Type **XXX**: In areas requiring window sprinkler protection.~~

~~a. Standard Coverage, fast response, **[ordinary] [intermediate]** temperature class **[68°C(**155°F**)] [93°C(**200°F**),] [horizontal sidewall] [pendent vertical sidewall]**, Tyco Fire Products Model WS or equal.~~

~~12. Type **[XXX]**: In the following rooms:~~

~~a. Same as Type **[XXX]** except with wire cage sprinkler guard. Guards must be **[Listed] [FMRC Approved]** with sprinkler on which they are installed.~~

F. Submit samples for examination and approval when appearance is different than sprinkler head specified.

G. Temperature class of sprinkler heads shall vary if installed close to heat sources, under skylights or in special hazard areas. Refer to NFPA 13 for requirements.

H. Provide high pressure sprinklers where pressures exceed ~~**1205 kPa(**~~175 psi~~**)**~~ working water pressure.

I. Sprinkler Cabinets:

1. Shall be complete with required number of spare sprinkler heads of each type and temperature rating per NFPA 13
2. Shall be provided with at least one sprinkler wrench for each type of sprinkler installed
3. Provide multiple cabinets to meet this requirement.
4. Coordinate cabinet locations with Owner's representative.

~~2.14 FIRE HOSE CABINETS (FHC)~~

~~A. Manufacturers:~~

~~1. Acceptable Manufacturers: American Fire Hose & Cabinet, Badger-Powhatan, Croker Corp., Elkhart Brass, Fire End, Guardian Fire Equipment, Potter-Roemer, or equal~~

~~B. Hose Cabinets:~~

~~1. FHC~~

~~a. Cabinet: **[surface mounted] [semi-recessed] [recessed]**, Potter-Roemer Series **[XXX] [FRC]**, or equal.~~

~~b. Door Style: **[Full Glass] [Break Glass] [Solid Metal]**, white polyester coating with identifying decal.~~

~~c. Hose Rack Assembly for **[Class II] [Class III]** service.~~

~~2.15 FIRE VALVE CABINETS (FVC)~~

~~A. Manufacturers:~~

~~1. Acceptable Manufacturers: American Fire Hose & Cabinet, Badger-Powhatan, Croker Corp., Elkhart Brass, Fire End, Guardian Fire Equipment, Potter-Roemer, or equal~~

~~B. Fire Valve Cabinets:~~

~~1. FVC-1:~~

~~a. Cabinet: recessed, Potter-Roemer Series 1810 **[FRC]** or equal.~~

~~b. Door Style: **[Full Glass] [Break Glass] [Solid Metal]**, white polyester coating with identifying decal.~~

~~c. Angle Valve: Female x Male, **65 mm(**2-1/2”**)** cast brass body, **[polished brass] [rough brass] [polished chrome plated]** finish, equal to Potter-Roemer Model 4065. Valve cap for **65 mm(**2-1/2”**)** valve shall be **[65 mm(**2-1/2”**) x 40 mm(**1-1/2”**) hose adapter reducer, Potter-Roemer Model 2810 or equal, with 40 mm(**1-1/2”**) cap with chain, Potter-Roemer Model 4615, or equal] [65 mm(**2-1/2”**) cap with chain, Potter-Roemer Model 4625 or equal]**. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.~~

~~2. FVC-2:~~

~~a. Cabinet: surface mounted, Potter-Roemer Series 1815 or equal.~~

~~b. Door Style: **[Full Glass] [Break Glass] [Solid Metal]**, white polyester coating with identifying decal~~

~~c. Angle Valve: Female x Male, **65 mm(**2-1/2”**)** cast brass body, **[polished brass] [rough brass] [polished chrome plated]** finish, equal to Potter-Roemer Model 4065. Valve cap for **65 mm(**2-1/2”**)** valve shall be **[65 mm(**2-1/2”**) x 40 mm(**1-1/2”**) hose adapter reducer, Potter-Roemer Model 2810 or equal, with 40 mm(**1-1/2”**) cap with chain, Potter-Roemer Model 4615, or equal] [65 mm(**2-1/2”**) cap with chain, Potter-Roemer Model 4625 or equal]**. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.~~

~~2.16~~2.9 FIRE DEPARTMENT CONNECTION (FDC)

A. Manufacturers:

1. Acceptable Manufacturers: Croker Corp.; Dixon Fire; Elkhart Brass; Potter-Roemer; Tyco Fire Products; or equal

B. Fire Department Connection:

1. Provide flush type, cast brass body with drop clappers, faceplate shall be **[**polished brass**]** ~~**[rough chrome plated] [polished chrome plated] [XXX]**~~ finish, with lettering reading [AUTOSPKR] ~~**[AUTOSPKR STANDPIPE]**~~.

2. Unit shall include ~~**[2]**~~ **two,** [3~~**] [4] 65 mm(**~~2-1/2”**)** snoots with rigid end threading to match local fire department standards by pin-lug hose thread swivels, pin-lug plugs and chains. Finish of snoots shall match faceplate finish. Provide Elkhart Brass or equal.

~~3. Provide **[straight] [angled]**, rigid female large diameter hose (Storz) connection with **[100 mm(**4”**)] [130 mm(**5”**)] [150 mm(**6”**)]** outlet and cap. Basis of Design: Harrington Model **XXX**.~~

~~2.17 ROOF MANIFOLD~~

~~A. Acceptable Manufacturers: Croker Corp., Elkhart Brass, Potter-Roemer, or equal~~

~~B. Two-way connection, cast brass body with female NPT inlet and **65 mm(**2-1/2”**)** male NPT outlets, Croker Corp. **[6840]** [6860] Series or equal.~~

~~2.18~~2.10 BALL DRIP

A. Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products, or equal

B. Provide bronze ball drip for fire department connection (FDC) inside of building and pipe to nearest floor drain or discharge to exterior.

C. Exterior discharge location must be coordinated with Architect and Owner.

~~2.19 FIRE PUMP (FP)~~

~~A. Acceptable Manufacturers: A-C Fire Pump, Fairbanks Nijhuis, Patterson Pump, Peerless Pump, or equal~~

~~B. Fire pump shall meet following criteria:~~

~~1. Deliver rated flow at rated pressure~~
~~2. Deliver not less than 65% of rated pressure at 150% rated capacity~~
~~3. Not exceed 140% of rated pressure at shutoff~~

~~C. Pump Type: Electric Driven~~

~~D. Pump Configuration: **[Horizontal Split Case] [Vertical Inline] [Vertical Turbine] [End Suction]**~~

~~E. Rated Flow: **XXX L/s(**gpm**)**~~

~~F. Rated Pressure: **XXX kPa(**psi**)**~~

~~G. Pump casing shall be pressure rated to handle system pressure.~~

~~H. Pump and motor shall be mounted on common steel baseplate.~~

~~I. Motor:~~

~~1. Provide open drip proof, high-efficiency, foot-mounted.~~

~~2. **[200] [230] [460]** VAC, 3 Ph, **[60 Hz]** **[50 Hz]**, and **XXX rad/s(**rpm**)**~~
~~3. **XXX kW(**hp**)**~~
~~4. Locked rotor current shall not exceed values specified in NFPA 20.~~

~~J. Accessories to be provided with each fire pump are as follows:~~

~~1. Fire Pump Test Connection:~~
~~a. Test connection shall be flush type, cast brass body, polished **[chrome] [brass]** plated with lettering reading "PUMP TEST CONNECTION".~~
~~b. Unit shall include **[two] [three] [four] 65 mm(**2-1/2"**)**, polished **[chrome] [brass]** plated caps with chains.~~
~~c. Potter Roemer Model **[XXX]** or equal~~

~~2. Discharge pressure gauge and compound suction gauge shall be liquid-filled type.~~

~~3. Circulation Relief Valve: **19 mm(**3/4"**)** Cla-Val Model 55L pressure relief valve or equal~~
~~4. Automatic Air Release Valve~~

~~a. Basis of Design: Aurora Model **XXX**~~

~~2.20 CONTROL EQUIPMENT FOR ELECTRIC DRIVE~~

~~A. Acceptable Manufacturers: Eaton, Firetrol, Joslyn Clark, Metron, or equal~~

~~B. Fire Pump Controller:~~

~~1. Shall be completely assembled, wired and tested by control manufacturer before shipment from factory~~
~~2. Shall be labeled "Fire Pump Controller"~~
~~3. Shall be located as close as practical and within sight of motor~~
~~4. Shall be located and protected such that it will not be damaged by water escaping from pump or connections~~
~~5. Shall be combined manual and automatic~~
~~6. Heavy gauge formed steel, NEMA Type 2 enclosure with top drip hood~~
~~7. Provide complete with following:~~
~~a. Starter: **[Reduced Voltage wye-delta closed] [Reduced Voltage wye-delta open] [Reduced Voltage Solid State] [Reduced Voltage Auto Transformer] [Reduced Voltage Part Winding] [Reduced Voltage Primary Resistor] [Full Voltage Across-the-Line]**~~
~~b. Isolating Switch: Externally operable, quick-break type~~
~~c. Circuit breaker: Rated at **XXX** KAIC at **XXX** VAC~~
~~d. Locked rotor protector for drive motor~~
~~e. Pilot light to show circuit breaker closed and power available~~

~~f. Ammeter and voltmeter displays on front of panel~~
~~g. Alarm relay to energize audible or visible alarm~~
~~h. Pressure recording device~~
~~i. **[With Automatic Transfer Switch]**~~
~~j. Voltage surge protection~~
~~k. Contacts for remote alarm of:~~
~~1). Pump Running~~
~~2). Loss of Line Power in any phase~~
~~3). Phase Reversal~~
~~4). Controller Connected to Alternate Source~~
~~l. **[Provide remote fire pump alarm panel in a location of constant attendance.]**~~
~~1). **[Remote pump alarm panel shall be key lockable enclosure consisting of audible or visible alarms.]**~~
~~2). Alarms shall show: "Pump Running"; "Supervisory Power Failure"; "Phase Reversal" and, when required by NFPA 20, "Controller Connected to Alternate Source".~~

~~C. Basis of Design: Eaton Model **[XXX]**~~

~~2.21 JOCKEY PUMP (JP)~~

~~A. Acceptable manufacturers: A-C Fire Pump, Fairbanks Nijhuis, Patterson Pump, Peerless Pump, or equal~~

~~B. Jockey pump shall be:~~

~~1. Same manufacturer as main fire pump~~
~~2. Centrifugal jockey pump rated for **XXX L/s(**gpm**)** at **XXX kPa(**psig**)**~~

~~C. Pump casing shall be pressure rated to handle system pressure.~~

~~D. Motor shall be:~~

~~1. **XXX kW(**hp**)**~~
~~2. **XXX rad/s(**rpm**)**~~
~~3. **[200] [230] [460]** VAC~~
~~4. 3 Ph, Jockey pump shall be close-coupled.~~
~~5. Open Drip Proof (ODP)~~
~~6. Pump and motor shall be integrally mounted on common steel baseplate.~~

~~E. Basis of Design: Aurora Model **XXX**~~

~~2.22 JOCKEY PUMP CONTROLLER~~

~~A. Acceptable manufacturers: Eaton, Firetrol, Joslyn Clark, Metron, or equal~~

~~B. Jockey pump controller shall be same manufacturer as main fire pump controller.~~

~~C. Jockey pump controller:~~

~~1. Wall mounted, NEMA Type **[2] [3R]** control cabinet~~

~~2. Maintain automatic sprinkler system at **35-70 kPa(**5-10 psi**)** above fire pump starting pressure.~~
~~3. Mercury-free pressure switch with independent adjustment~~
~~4. Multiple position control switch~~
~~5. 3-pole disconnect switch~~
~~6. Starter~~

~~D. Basis of Design: Eaton Model **XXX**~~

~~2.23~~2.11 HANGERS

A. Acceptable manufacturers: Afcon, Anvil, Eaton, Pentair, Tolco, or equal

B. Concrete expansion hangers, when provided, are to be Hilti, Illinois Tool Works (ITW), Powers Fasteners, or equal

C. Hanger rods shall comply with Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.

D. Provide hanger rod, hanger rod attachments, pipe stands, bolts, u-bolts, nuts, studs and washers with electroplated zinc coating or with hot-dipped galvanized finish.

E. ~~**[Hangers for stainless steel pipe shall be of stainless steel construction.]**~~

F. Riser clamps shall be electroplated zinc coated or have a hot-dipped galvanized finish and shall not protrude more than ~~**50 mm(**~~2"~~**)**~~ beyond edge of hole, Anvil Fig. 261 or equal.

~~2.24 [EARTHQUAKE BRACING~~

~~A. **Sprinkler [and standpipe] system shall be protected from earthquake influence in accordance with requirements of NFPA 13 and as outlined in Section 20 0549 – Seismic Anchorage and Restraints.**~~

~~B. **Provide flexible couplings, bracing, and other components required, compatible with piping material and jointing system used.**~~

~~C. **Seismic detailing shall be included on contractor's fire protection system installation drawings.**~~

~~D. **[Seismic support shall be in accordance with FMG Property Loss Prevention Data Sheet 2-8, Earthquake Protection for Water-Based Fire Protection Systems.]]**~~

~~2.25~~2.12 PRESSURE GAUGES

A. Acceptable manufacturers: Ashcroft, Potter-Roemer, Viking, or equal

B. Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" NPT.

C. Include ball valve with provisions for draining on each pressure gauge.

~~2.26~~2.13 DIELECTRIC FITTINGS

A. Acceptable manufacturers: Epco Sales, Lochinvar, Watts Regulator Co., Wilkins, or equal

B. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation or equal.

C. Dielectric unions 2” and smaller; dielectric flanges 2” and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, and pressure rating of not less than 175 psig at 180°F. Provide high pressure type when pressures exceed 175 psi water working pressure.

PART 3 - EXECUTION

3.1 DESIGN CRITERIA

A. Flow Test:

1. Static Pressure: **86**~~XXX~~ ~~kPa(~~psig~~)~~
2. Residual Pressure: ~~XXX~~ **79**~~kPa(~~psig~~)~~ with ~~XXX~~ **1330** ~~L/s(~~gpm~~)~~ flowing
3. ~~Flowing hydrant is located at XXX and pressure-test hydrant is located at XXX.~~

~~4.~~**3.** Test Date: ~~XXX~~**05-31-2012**
~~5.~~**4.** Test Time: ~~XXX~~**15:30**
~~6.~~**5.** Elevation of pressure-test hydrant: ~~XXX~~**Not available**
~~7.~~**6.** Test conducted by or information supplied by: ~~XXX~~ **Universal Fire Systems**

B. Sprinkler Contractor, prior to preparation of installation drawings and hydraulic design calculations, shall **[**conduct a hydrant flow test~~]~~ ~~**[ensure that a hydrant flow test is conducted]**~~ ~~within the last~~ ~~**[12]**~~ ~~months~~.

C. Send current hydrant flow test data to Engineer.

~~D. **[Fire pump shall be designed to meet fire protection system demand.]**~~

~~E.~~**D.** Hydraulically calculated system ~~[~~shall ~~**] [is not required to]**~~ be designed to a minimum of ~~**[5%] [10%] [35 kPa(**~~5 psi~~**)] [70 kPa(**~~10 psi ~~**)]**~~ below available water flow curve.

~~F.~~ Systems that are hydraulically calculated must include 1.2 factor for design area. ~~**[Systems that are hydraulically calculated must include a 1.2 factor for design areas having ceilings with slopes less than or equal to 5° and a 1.4 factor for design areas having ceilings with slopes greater than 5°.]**~~ **See Drawings for room, names, uses and hazard descriptions. Densities and hose stream allowances shall be provided in the drawings.**

E.

~~G. Basis of Design:~~

~~1. Office areas and general building spaces shall be hydraulically designed to provide minimum density of **XXX mm/min(**gpm**)** per **m²(**sq ft**)** over most hydraulically remote **XXX m²(**sq ft**)**. Maximum spacing shall not exceed **XXX m²(**sq ft**)** per head.~~

~~2. Laboratory areas, including corridors between labs separated from office areas by doors and firewalls, shall be hydraulically designed to provide minimum density of **XXX mm/min(**gpm**)** per **m²(**sq ft**)** over most hydraulically remote **XXX m²(**sq ft**)**. Maximum spacing shall not exceed **XXX m²(**sq ft**)** per head.~~

~~3. Clinical and patient areas, including corridors shall be hydraulically designed to provide minimum density **XXX mm/min(**gpm**)** per **m²(**sq ft**)** over most hydraulically remote **XXX m²(**sq ft**)**. Maximum spacing shall not exceed **XXX m²(**sq ft**)** per head.~~

~~4. Penthouse and other mechanical equipment areas shall be hydraulically designed to provide minimum density of **XXX mm/min(**gpm**)** per **m²(**sq ft**)** over most hydraulically remote **XXX m²(**sq ft**)**. Maximum spacing shall not exceed **XXX m²(**sq ft**)** per head.~~

~~5. General storage areas and chemical transfer area shall be hydraulically designed to provide minimum density of **XXX mm/min(**gpm**)** per **m²(**sq ft**)** over most hydraulically remote **XXX m²(**sq ft**)**. Maximum spacing shall not exceed **XXX m²(**sq ft**)** per head.~~

~~H.~~**F.** Hose Streams:

~~1. Add **XXX L/s(**gpm**)** hose stream to sprinkler zone hydraulic calculations, at **XXX**, for Light Hazard Occupancies.~~

~~2.~~**1.** Add ~~XXX~~ **50** ~~**L/s(**~~gpm~~**)**~~ hose stream to sprinkler zone hydraulic calculations, at ~~XXX~~**base of main riser**, for Ordinary Hazard Occupancies.

~~3. Add **XXX L/s(**gpm**)** hose stream to sprinkler zone hydraulic calculations, at **XXX**, for Extra Hazard Occupancies.~~

~~I.~~**G.** Fire Protection System Layout and Installation Drawings:

1. Contractor shall review Design Drawings and Specifications, and shall provide installation drawings, calculations, and product datasheets.

~~2. Layout of fire protection system has been established for **XXX** level only, as it relates to structure, and mechanical/electrical systems in building, and must be adhered to. Other layouts shall be produced by Contractor in coordination with building components.~~

~~3.~~**2.** Conceal sprinkler piping above ceilings where possible.

~~4.~~**3.** Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.

~~5.~~**4.** Submit stamped and sealed installation drawings, calculations and product data sheets for coordination review to: local Fire Department, Engineer, Architect, Owner's insurance representative, City of ~~XXX~~ **Lakeland** and other Authorities Having Jurisdiction prior to installation (see submittals).

~~6.~~**5.** Contractor shall be responsible to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.

~~7.~~**6.** Contractor shall coordinate routing of piping with other trades and Architect.

~~8.~~**7.** Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.

3.2 INSPECTION

A. Investigate site conditions; verify utility locations and elevations before start of excavation. Forward discrepancies to Architect/Engineer before proceeding with construction.

3.3 INSTALLATION

A. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.

B. Install hydraulically designed standpipe system and associated accessories according to requirements of NFPA 14 and as shown on drawings.

C. Install pipe, fittings, couplings, and valves according to requirements of manufacturer.

~~D. **[Provide nonferrous metal pipe in MRI area(s).]**~~

~~E. **[Provide stainless steel pipe, fittings, sprinkler heads, and hangers in cooling towers.]**~~

~~F. **[All tools used for fabrication and installation of stainless steel pipe and fittings shall be dedicated for use on stainless steel materials only.]**~~

~~G.~~**D.** Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.

~~H.~~**E.** Pipe and fittings shall be of corresponding materials when assembled.

~~I.~~**F.** Below Ground Pipe:

1. Anchors and tie rods can be provided in lieu of thrust blocks. Tie rods shall be 3/4” diameter steel rod. Clamps shall be 3/8” thick by 2” wide steel. Each clamp shall be secured with four 5/8” diameter bolts.
2. Apply asphaltum or approved corrosion inhibitive paint, to tie rods, clamps and bolts of underground pipe.
3. Provide metallic bond at each joint of ductile iron and cast iron pipe. Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.

~~J.~~**G.** Above Ground Pipe:

1. Provide pipe identification system with flow directional arrows on fire protection pipe in accordance with manufacturer’s installation instructions. For additional information, refer to Section 20 0553 – Mechanical Systems Identification.
2. Coat exposed threads **subject to unconditioned air** with corrosion inhibitive paint, equal to Rust-Oleum. Apply paint per manufacturer’s instructions.

~~K.~~**H.** Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2”.

~~L.~~**I.** Provide test connection for each flow switch.

~~M.~~**J.** Discharge test connections inside building to receptacles provided as part of plumbing system or to standpipe’s drain riser. ~~[Outside discharge shall not be allowed.]~~ [Outside discharge is preferred.~~]~~

~~N.~~**K.** Drain line detailed adjacent to standpipe/sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.

~~O.~~**L.** Provide auxiliary drains at low points of systems per requirements of NFPA 13.

~~P.~~**M.** Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.

~~Q.~~**N.** Clamp-on or saddle type fittings (i.e. mechanical tees) are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.

~~R.~~**O.** Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.

~~S. Piping and fittings between preaction or deluge or dry pipe valves and sprinkler heads and test/auxiliary drain piping of dry sprinkler systems shall be **[galvanized steel] [copper] [stainless steel]** to retard or eliminate corrosion due to oxidation in these sub-systems. Provide dielectric fittings between dissimilar pipe materials.~~

~~T.~~**P.** Feed sprinkler heads, installed in finished ceilings, with ~~**[FlexHead,]**~~ swing joint, or return bend arrangement for final positioning in ceiling grid pattern during construction phases.

~~U.~~**Q.** Sprinklers ~~[~~are~~**] [are not]**~~ required to be installed in the center of ceiling tiles.

~~V. **[Provide minimum 25 mm(**1”**) outlets with sprigs or drops for sprinklers located in shelled spaces.]**~~

~~W.~~**R.** Install tamper switch on each shutoff valve.

~~X.~~**S.** ~~[~~Install locking device with each shutoff valve to prevent inadvertent closing of valve. Keys shall be indexed to identify valve location.~~]~~

~~Y.~~**T.** Install sprinkler heads as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional heads beneath obstruction.

~~Z.~~**U.** Make joints of threaded pipe by cutting pipe square and reaming inside.

~~AA.~~**V.** Use joint compound sparingly.

~~BB.~~**W.** Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer’s gasket lubricant sparingly.

~~CC.~~**X.** Pipe grooving shall be per coupling manufacturer’s instructions.

~~DD.~~**Y.** Welded joints shall be made in fabrication shop. No welding allowed at project site.

~~EE.~~**Z.** Hangers, Bracing, and Restraint of System Piping:

1. Provide hangers and associated parts to support piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13 and manufacturer’s installation instructions.
2. Select and size building attachments per Manufacturer Standardization Society (MSS) standards and manufacturer’s published load rating.
3. Coordinate hanger support installation to group piping of all trades.

4. Hang pipe from building members using either concrete inserts for concrete construction or beam clamps for steel construction. Installation shall comply with manufacturer's installation instructions. Expansion type inserts may be used for branch piping.
5. Restraining clips/clamps are required in locations where vibration may be a concern. Refer to Section 23 0550 – Vibration Isolation, for additional information regarding restraining clips/clamps.
6. Suspend hangers by means of electroplated zinc or hot-dipped galvanized finish hanger rods. Perforated band iron and flat wire straps (strap iron) are not allowed.
7. Mains parallel to joists shall not be supported from a single joist. Mains parallel to joists shall be supported by trapeze hanger and be positioned equally between two joists. Trapeze hangers shall be positioned to load joists at panel points only.
8. Support pipe from top flange of beams.
9. Where joists are used, locations of pipe supports shall be approved by the structural engineer prior to installation.
10. Do not support equipment or piping from metal roof deck.

~~FF. **[Support piping in accordance with NFPA 13 and Section 20 0549 – Seismic Anchorage and Restraints, and in accordance with State and Local seismic restraint requirements.]**~~

~~GG. **[Include seismic restraint details with sprinkler installation drawings.]**~~

~~HH. Install flexible fitting at building's **[expansion] [seismic]** joints per manufacturer's instructions.~~

~~II.~~**AA.** Install pressure gauges ~~**[as shown on engineering drawings,]**~~ as required in manufacturer's installation instructions, and as required per NFPA standards.

~~JJ. Generally install capped tees in lieu of couplings for future connections. Specifically, cap tees **[in] [below] [XXX]** area from sprinkler zone in **XXX** area, for future protection of **XXX**.~~

~~**3.4** FIRE PUMP INSTALLATION~~

~~A. Install fire pump, jockey pump and their controllers per manufacturer's installation instructions, as shown on drawings and as required in NFPA 20.~~

~~B. Grout base-mounted pumps after securely anchoring to structure.~~

~~C. Coordinate installation with Division 26 and Division 28 contractors.~~

~~3.5~~3.4 CLEANING

~~A. Flush sprinkler system serving **[data center(s)] [server room(s)] [clean rooms(s)] [XXX]** to purge cutting oil, debris and metal fines.~~

~~B.~~**A.** Ensure underground feed pipe has been flushed per NFPA 24 to clear out construction debris, prior to connecting aboveground fire protection system to it.

~~C.~~**B.** Clean systems after installation is complete.

~~D.~~**C.** Clean piping both internally and externally to remove dirt, plaster dust, or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition. Replacement of heavily soiled and deteriorated materials shall be done at the Contractor's expense.

~~E.~~**D.** Clean equipment as recommended by manufacturers. Thoroughly clean equipment of stains, paint spots, dirt, dust, and any other foreign materials. Remove temporary labels not used for instruction or operation.

~~3.6~~3.5 TESTING

A. Refer to testing paragraph of Section 20 0000 – General Mechanical Requirements.

B. Coordinate fire pump test with Division 26 and Division 28 contractors.

C. Perform all NFPA required acceptance tests.

D. Test sprinkler system as entire system or partial system. System shall be hydrostatically tested at not less than 200 psi or 50 psi above static pressure in excess of 150 psi for 2 h. No leakage allowed. Replace defective joints with new materials. No caulking of defective joints allowed. Re-test system after defective joints are replaced, until satisfactory results are obtained.

E. Hydrostatically test piping between the exterior fire department connection (FDC) and the check valve in the fire department inlet pipe in the same manner as the balance of the system.

F. Pipe shall not be concealed until satisfactorily pressure tested.

~~G. In addition to hydrostatic test, **[preaction] [dry pipe]** system shall be air pressure tested at **280 kPa(**40 psi**)** for 24 h. Leakage in excess of **10 kPa(**1-1/2 psi**)** during 24 h will not be permitted.~~

~~H.~~**G.** Conduct drain test. Record static pressure and residual pressure per NFPA 13.

~~I.~~**H.** Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.

~~J.~~**I.** Log of tests shall be kept at job site and shall identify:

1. Who performed test
2. Time of test
3. Date of test
4. Section of system tested
5. Results of test
6. Completed Contractor's Material and Test Certification form(s) from NFPA 13 ~~**[and NFPA 14]**~~

~~K.~~**J.** Operate flow ~~**[and pressure]**~~ switches to test that signals are transmitted to Fire Alarm Control Panel.

~~L.~~**K.** Include test for tamper switches.

~~3.7 FIRE PUMP TESTING~~

~~A. Test fire pump, jockey pump and their controllers per manufacturer's installation instructions and as required in NFPA 20.~~

~~B. Furnish test certificate indicating suction pipe has been flushed and suction and discharge pipe has been hydrostatically tested in accordance with NFPA 20, prior to fire pump acceptance test.~~

~~C. Coordinate fire pump acceptance test so Local Authorities, Owner's representatives, and Insurance Company representatives can witness the test.~~

~~D. Owner's representative or Engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.~~

~~E. Representatives from following shall be present for fire pump field acceptance test:~~

~~1. Pump manufacturer~~
~~2. Controller manufacturer~~

~~3. **[Transfer switch manufacturer]**~~

~~F. Coordinate fire pump test with local utilities to verify acceptable method for disposal of water.~~

~~G. Provide equipment to perform fire pump test, including:~~

~~1. Calibrated test gauges~~
~~2. Calibrated tachometer~~
~~3. Hoses~~
~~4. Nozzles~~
~~5. Valves~~

END OF SECTION 211314

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SECTION 220594 - DOMESTIC WATER SYSTEMS BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 22 1118 – Water Distribution System

B. Section 22 2114 – Plumbing Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Plumbing Contractor shall be responsible for providing complete testing and balancing work of liquid fluid handling systems, such as domestic hot water return, laboratory hot water return, water mixing valves, and other processes included in this Project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports as specified herein.

C. Scope of work includes new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes existing liquid fluid handling systems as defined by drawings and/or schedules.

E. Work is limited to new areas within construction boundaries and does not include central pumping equipment or other areas. Adjust and balance flows to values indicated or scheduled. If flow is abnormal, attempt to proportional balance flows to the same percentage below design and contact Engineer for additional instruction.

F. Procedures shall be in accordance with the latest edition of AABC or NEBB and as per detailed herein.

G. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval.

H. Contractors who are members of AABC or NEBB and who have qualified personnel available to perform Work may submit Quality Assurance Submittal for approval. Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

I. Owner will separately contract with an independent TAB Contractor to perform all testing, adjusting and balancing of HVAC hydronic systems required for this Project. Work related to

testing, adjusting, and balancing that must be performed by Mechanical Contractor is specified in other sections of these Specifications.

J. Upon direction of Architect/Engineer or TAB subcontractor, Contractor shall provide (at no additional cost to Owner) any additional work and/or devices necessary to properly balance the system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at minimum pressure differential.

K. TAB work shall not proceed until all assigned personnel have been approved by, Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be complete before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Engineer.

1.4 SUBMITTALS

A. General:

1. Make submittals in accordance with Section 01 3300 – Submittals. Submit minimum of 5 copies of all submittals unless otherwise directed.
2. Reports shall be assembled using a 3-ring hard cover binder with Project Name and location on the cover and the side panel. Information sheets shall be 8-1/2” x 11” white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Assemble report in the following order.
   a. Transmittal letter
   b. Cover sheet with Project title, location, submittal date, and names and addresses of Owner, Contractor, TAB subcontractor, Architect, and Engineer
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:
      1). Equipment data and measurement summary
      2). Equipment measurement data
      3). Branch main measurement data
      4). Terminal device measurement data
   e. Provide numbered tabs for each system.

B. Quality Assurance Submittal:

1. Within 30 days of signing Contract, Contractor shall submit the following information:
   a. Firm resume
      1). AABC or NEBB active membership required
      2). Names of 3 recent relevant completed projects along with the project address, Owner's contact person, supervising design professional.
   b. Supervisor resume
   c. Balance technician(s) resume

2. Architect/Engineer and Owner reserve the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this Project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3-EXECUTION of this Section to demonstrate to Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before fieldwork starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to A/E and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of the NEBB, the American Society of Plumbing Engineers (ASPE) and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. Project schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Set point for individual branch balancing valves in domestic hot water return systems[s] shall be 0.5 gpm unless otherwise noted on drawings or schedules.

C. Set point for domestic hot water return circulating pump shall be the flow rate defined in schedules on drawings.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain latest contract documents including addenda and change orders. Obtain shop drawings and performance curves from Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.
   a. Narratives:
      1). Provide written narratives of procedures used. Provide separate narratives for each pump and liquid fluid handling system.
      2). Identify flow-measuring devices to be used at each pump and terminal device. Provide different narratives for constant and variable flow systems.
      3). For non-standard water systems, include narratives on how to measure and adjust for different viscosities.
      4). Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. For this Project, minimum acceptable is ± 10% of design flow.
   b. Prebalance Checklist: include, but not limited to:
      1). Check for completeness or work
      2). System cleaning
      3). System fill and air venting
      4). Place system into operation
      5). Check expansion tanks and fill pressures
      6). Pump bearings, alignment, starters, vibration isolators, rotation
      7). Setting valves to proper position including shutoff and bypass valves
      8). Set up of controls and control devices
   c. Measuring Instrument List: list measuring instruments to be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
      1). Manufacturer name and model number
      2). Measurement range
      3). Pressure/temperature limits
      4). Date put into service
      5). Date of last calibration
      6). Include certificate from calibration firm

2. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within the past year.
3. Samples: Submit copies of TAB forms to be used.
4. Branch circuit and terminal measurements: indicate on pre-printed forms of AABC or NEBB measurements to be taken in the field. Include branch circuit or terminal identification, system, space served, location, design flows (include zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate initial setpoint on forms.

3.3 SET-UP PHASE

A. Procedure:

1. Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure pump data and flows in "as found" condition after initial valve settings are made.

C. Initial Test Report:

1. Submit report to Architect/Engineer and Contractor indicating measurements made and make notes of items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

1. Submit report to Engineer and to Contractor indicating data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

1. Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within the design tolerance of ± 10% of design flow. Contractor shall resubmit all or portions of Final Report as directed by Engineer.

END OF SECTION 220594

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SECTION 221118 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers interior domestic cold water, domestic hot water domestic hot water return, nonpotable cold water and trap filler lines to a point 5 ft outside building wall.

B. All components shall comply with NSF-61 and NSF-372 to be compliant with requirement for lead content of ≤0.25% maximum weighted average.

1.2 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) Systems

C. Section 20 0520 - Excavation and Backfill

D. Section 20 0529 - Piping and Equipment Supporting Devices

E. Section 20 0553 - Mechanical Systems Identification

F. Section 20 0700 - Mechanical Systems Insulation

G. Section 22 0594 - Domestic Water Systems Balance

H. Section 22 2114 - Plumbing Specialties

I. Section 26 2913 - Enclosed Controllers

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 QUALITY ASSURANCE

A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

E. Before shipping, piping shall be cleaned, free of rust and scale, and chemically treated to protect inside of pipe from rusting and furnished with end caps.

1.6 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe
2. Fittings
3. Joints
4. Valves
5. Unions and Flanges
~~5.~~**6. Water meters**
~~6.~~**7.** Dielectric fittings
~~7.~~**8.** Water hammer arrestors
~~8.~~**9.** Expansion joints
~~9.~~**10.** In-line Centrifugal Pumps

B. Shop Drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

B. Materials shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.

2.2 PIPE, FITTINGS, AND JOINTS

A. Pipe, fittings, and joints for Water Main in Section 22 1114 - Exterior Services to 5 ft from outside building wall.

B. Underground 2-1/2" and Smaller:

1. Copper:
   a. Pipe: Copper tube, Type K, soft (annealed) temper in coils, ASTM B88
   b. Fittings:
      1). Cast copper alloy, solder joint, pressure rated, ANSI B16.18
      2). Wrought copper, solder joint, pressure rated, ANSI b16.22
   c. Joints: Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813
   d. Joints: Where joints are permitted, brazed, silver solder, BCuP-5 Type, AWS.A5.8, 1250°F melting point minimum.
   e. Pre-insulated with polyurethane insulation and PVC jacket.

C. Underground 3" and Larger:

1. Ductile Iron:
   a. Pipe: Ductile iron, Class 52, AWWA C151, with standard cement mortar lining, AWWA C104
   b. Fittings:
      1). Ductile iron or grey iron, mechanical joint, cement mortar lined, Class 250, AWWA C110
      2). Ductile iron, mechanical joint compact fittings, Class 350, AWWA C153
   c. Joints: Joint shall be restrained type equal to EBAA Iron Megalug 1100 restraint system for mechanical joint for ductile iron pipe, AWWA C111/A21.11 and AWWA C153/A21.53 Joints shall be designed to accommodate deflection after assembly up to 3°.
   d. Encasement: provide 8 mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105

D. Above Ground:

1. Copper (2-1/2” and Smaller):
   a. Pipe: Copper tube, Type L, hard drawn, ASTM B88
   b. Fittings:
      1). Cast copper alloy, solder joint, pressure rated, ANSI B16.18
      2). Wrought copper, solder joint, pressure rated, ANSI B16.22
   c. Joints:
      1). Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813
   d. Nipples: Red brass pipe, threaded
   e. Exposed tubing and fittings in kitchen and areas subject to chemical cleaning shall have chrome plated finish.

2. Copper (3” thru 8”):
   a. Pipe: Copper tube, Type L, hard drawn, ASTM B88
   b. Fittings:
      1). Cast copper alloy, solder joint, pressure rated, ANSI B16.18
      2). Wrought copper, solder joint, pressure rated, ANSI B16.22
   c. Joints: Brazed, BCuP-3 or BCuP-5 type, AWS A5.8, 1250°F minimum melting point

2.3 UNIONS AND FLANGES

A. General:

1. Unions, flanges and gasket materials to have pressure rating of not less than 150 psig at 180°F.

B. Copper (3” and Smaller):

1. Wrought copper union, Nibco Figure 633-W. Mueller Brass equal.

C. Copper (4” and Larger):

1. Cast red brass flanges, alloy 844, ASTM B584, Class 150, Standard bolt pattern, ANSI B16.24 with neoprene gasket

2.4 VALVES

A. Shutoff Valves:

1. Ball Valves 4” and smaller):
   a. Acceptable manufacturers: Apollo, Hammond, Milwaukee, Nibco, Stockham and Watts with indicated features and equal to model listed. Note that not all manufacturers make all sizes.
   b. Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Apollo Series 77CLF-240-01
   c. Full Port, 3 Piece: Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Apollo Series 82LF-240
   d. Standard Port, 2 Piece: Bronze body, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Apollo Series 70LF-240-01
   e. Insulated Handle: For insulated systems to prevent condensation on valve body with thermal and vapor seal, equal to Apollo Therma Seal.

2. Butterfly Valves (6” and larger):
   a. Acceptable Manufacturers: Apollo, Hammond, Kitz, Milwaukee, Nibco, and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes or styles.
   b. Threaded or Solder Ends: Bronze body, stainless steel disc and stem, viton disk seal, Milwaukee Series BB2
   c. Lug Type: Ductile iron body, 316 stainless steel disc mounted without pins or bolts, EPDM liner, stainless steel stem, copper or glass reinforced epoxy resin bushings (lower, upper and collar), 200 psi CWP pressure rating, 10 position lever handle through 6”, gear operator 8” and larger, Apollo LD141
   d. Wafer Type: Ductile iron body, 316 stainless steel disc mounted without pins or bolts, EPDM liner, stainless steel stem, copper or glass reinforced epoxy resin bushings (lower, upper and collar), 200 psi CWP pressure rating, 10 position lever handle through 6”, gear operator 8” and larger, Apollo WD141

      1).

3. Gate Valves:
   a. Acceptable Manufacturers: Apollo, Crane, Hammond, Kennedy, Milwaukee, Nibco, and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes.
   b. Size 2-1/2” and Smaller: Lead-free bronze body, bronze trim, 150 psi steam pressure rating, union bonnet, rising stem, Apollo 102TLF/102SLF.
   c. Size 3” and Larger: Nickel iron body and wedge, stainless steel trim, outside screw and yoke (OS&Y), 125 psi steam pressure rating, bolted bonnet, flanged pipe endsNibco F-617-13

B. Swing Check Valves:

1. Size 2” and Smaller:

a. Bronze body, ASTM B62, Y pattern, Buna-N resilient disc, horizontal swing, 200 psi CWP rating, Apollo 163S-LF series

2. Valves 2-1/2” and Larger:
   a. Nickle iron body, horizontal swing, stainless steel or nickel iron disc, stainless steel replaceable seat, 200 psi CWP rating, Nibco F-918-13

C. Spring Check Valves:

1. Valves 2” and Smaller:
   a. Bronze body, ASTM B584, in-line lift type with spring, Buna-N or PTFE disc, 250 psi CWP rating, Apollo 61LF-500 series

2. Valves 2-1/2” and Larger:
   a. Cast iron body, wafer type, Buna-N seat, aluminum bronze disc, in-line type with stainless steel spring, 250 psi CWP rating, Nibco W-910-W-LF
   b. Ductile iron body, aluminum bronze or elastomer encapsulated ductile iron disc, stainless steel spring and shaft, welded-in nickel or EPDM synthetic rubber seat, vertical or horizontal installation, grooved ends, 300 psi CWP rating, Victaulic Series 716.

3. Size 1/2” thru 2”:
   a. Stainless steel body, in-line pattern, stainless steel seats, spring and valve disc. DFT, Inc. Basic Check, Model BSS, rated for 300 psi WSP.
   b. Manufacturers: Nibco, Watts, Mission, DFT, Inc., Circle Seal, Milwaukee, Stockham

D. Balancing Valves:

1. Circuit Setter:
   a. Acceptable Manufacturers: Bell and Gossett, Watts or approved equal
   b. 2” and Smaller: Shall be of lead-free bronze construction with glass and carbon-filled TFE seat rings and have differential pressure read-out ports across valve seat area. Read-out ports to be filled with internal EPT insert and better connection with check valve. Valve bodies to have 1/4” NPT tapped drain/purge port. Valves to have memory stop feature and calibrated nameplate to assure specific valve setting. Valve to be leak-tight at full-rated working pressure and temperature (300 psi/250°F). B&G Circuit Setter Model CB, or approved equal.

2. Globe Style Balancing Valve:
   a. Acceptable Manufacturers: Armstrong, Caleffi, Griswold, Nibco, or Red-White Valve
   b. Size 2” and Smaller: Valve shall be for precise regulation and control and rated 240 psi/250°F. Valve shall be constructed of dezincification resistant, lead-free brass (DZR) or bronze alloy. Valve shall be Straight Pattern Glove having 2 metering/test ports with internal check valves. Two 1/4” drain plugs and protective caps. Valve must be quipped with visual position readout and concealed memory stops for repeatable regulation and control. Nibco T or S-1810-LFor approved equal.

3. Constant Flow Balancing Device:
   a. Acceptable Manufacturers: IMI Flow Design, Caleffi; Eaton, or Victaulic

b. 1/2" thru 1": Nickel plated brass or 316 stainless steel body, flexible Buna-N insert that acts as variable orifice. Flow rates to be maintained to within ± 15% up to pressure drops of 125 psig. IMI Flow Design Model ICSS or approved equal.

4. Constant Flow Balancing Device:
   a. Acceptable Manufacturers: Griswold, Hayes Fluid Controls or approved equal
   b. 1/2" thru 1": Lead-free brass or 316 stainless steel wye pattern body, replaceable pressure independent flow control cartridge. Flow rates to be maintained to within ± 15% with pressure drops of 2-80 psig.Valve shall be factory marked with design flow rate. Griswold K Valveor approved equal.
   c. 1-1/4" thru 2-1/2": Lead free brass or stainless steel wye pattern body, replaceable pressure independent flow control cartridge. Flow rates to be maintained to within ± 15% with pressure drops of 2-80 psig. Valve shall be factory marked with design flow rate. Griswold K valve or approved equal**.**

E. Mixing Valves

1. MV-1 Thermostatic Master Mixing Valve
   a. Acceptable manufacturers: Armstrong, Lawler, Leonard, Powers or approved equal
   b. Master thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint at zero demand and peak flow with recirculated flow for temperature maintenance. Valve assembly shall be capable of sensing temperature in recirculated water temperature and returning water to main distribution if temperature is adequate or diverting partial flow to heater when temperature falls below setpoint.
   c. Mixing valve shall be bronze construction with dual thermostatic elements, integral thermometer, check valves, strainer, visual flow indicator and integral thermostatic return limiter. Valve shall be rated for 150 psig operating pressure and be certified under ASSE 1017.
   d. Valve shall have 140°F hot water inlet, 70°F cold water inlet and 120°F mixed water temperature with peak mixed water flow of ~~**[XXX]**~~**65** gpm. Armstrong Rada ~~**[320R] [425R] [40R] [**~~50R~~**]**~~ or equal.

2. MV-2 Thermostatic Central Tempered Water Mixing Valve
   a. Acceptable manufacturers: Lawler, Leonard, Powers or approved equal
   b. Master emergency fixture thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint. Valve shall fail to cold water supply only on loss of hot water supply. Valve shall fail closed on loss of cold water supply.
   c. Mixing valve shall be bronze construction with dual thermostatic elements, high temperature limit stop, locked temperature regulator and integral thermometers on inlet, outlet and mixed water lines. Valve shall be rated for 125 psig operating pressure and be certified per ANSI Z358.1 requirements.
   d. Valve shall have ~~**[XXX]**~~**120**°F hot water inlet, ~~**[XXX]**~~**65**°F cold water inlet and ~~**[XXX]**~~~~**[**~~85°F~~**]**~~~~°F~~ mixed water temperature with peak mixed water flow of **2**40 gpm. Leonard TM-5125 or equal.

3. MV-3 Thermostatic Point of Use Tempered Water mixing Valve
   a. Acceptable manufacturers: Lawler, Leonard, Powers or approved equal
   b. Master emergency fixture thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint. Valve shall fail to cold water supply only on loss of hot water supply. Valve shall fail closed on loss of cold water supply.

c. Mixing valve shall be bronze construction with dual thermostatic elements, high temperature limit stop, locked temperature regulator and integral thermometers on inlet, outlet and mixed water lines. Valve shall be rated for 125 psig operating pressure and be certified per ANSI Z358.1 requirements.

d. Valve shall have ~~**[XXX]**~~**120**°F hot water inlet, ~~**[XXX]**~~**65**°F cold water inlet and ~~**[XXX]°F [**~~85°F~~**]**~~ mixed water temperature with peak mixed water flow of 4 gpm. Leonard TA-350 or equal.

F. Pressure Reducing Valves – Point Of Use

1. Manufacturers: Apollo, Cla-Val Company, Watts Regulator Company, or Wilkins Regulator Division
2. High Temperature/Low Pressure Regulators:
   a. Self-contained regulator with cast bronze body, renewable stainless steel seat, spring loaded diaphragm, integral stainless steel strainer, union connection, 160°F maximum temperature rating, 200 psi maximum inlet pressure rating, and 25 to 75 psi adjustable reduced pressure range. Set pressure shall be **[XXX]**psi. Regulator shall be Watts No. LFU5B-Z3or approved equal.

G. Pressure Reducing Valve – Main System

1. Manufacturers: Apollo, Cla-Val Company, Fisher, Victaulic/Bermad, or approved equal
2. Pilot operated valve with low flow bypass, bronze body, globe pattern, stainless steel trim, Buna-N disc, stainless steel stem and spring, Class 300 Flanged ends, maximum service temperature 160°F.
3. Refer to Schedules on drawings for performance requirements.

H. WATER METERS

1. Sub metering units for LEED water verification

a. All cold water meters (compound type) furnished shall be produced from an ISO 9001 manufacturing facility and conform to AWWA C701 and AWWA C702. The size, capacity and meter lengths shall be as specified in AWA C701 and AWWA C702. The maximum number of disc nutation is not to exceed those specified in AWWA C701.

b. Meter maincases shall be made of epoxy-coated ductile iron composition. The serial number should be stamped between the outlet port of the maincase and the register. Maincase markings shall be cast raised and shall indicate size, model, direction of flow and NSF 61 certification. Plastic maincases are not acceptable.

c. All no-lead maincases shall be guaranteed free from manufacturing defects in workmanship and material for the life of the meter.

d. All meters must be adaptable to field programmable absolute encoder register without interruption of ht customer's service.

2. Bolts

a. All maincase bolts shall be 300 series non-magnetic stainless steel to prevent corrosion.

3. Remote capability

a. All meters shall be equipped with encoder remote registers according to AWWA C707 and shall meet all AWWA C700 performance standards. Meters and

encoders shall also be compatible with Advanced Metering Infrastructure (AMI) and Automatic Reading Systems.

4. Performance

a. To ensure accuracy, each meter must be accompanied by a factor test tag certifying the accuracy at the flows required by AWWA C700. All meters shall be warranted to 95 percent low flow accuracy.

5. Manufacturer

~~3.~~a. Meters and meter parts shall be manufactured, assembled and tested within the United States. Manufacturers shall have a minimum of 15 years of field and production experience with all sizes and models quoted. Acceptable meters shall be Sensus OMNI-C2 or approved equal.

2.5 DIELECTRIC FITTINGS

A. Insulating nipple, metal casing, inert thermoplastic lining; Anvil Figure 7090, Clearflow dielectric fitting by Perfection Corporation or Victaulic Style 47.

B. Dielectric unions 2” and smaller; dielectric flanges 2-1/2” and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F. Watts Regulator Company, Lochinvar, Wilkins or Epco Sales, Inc.

C. Copper-silicon casting, UNS C87850, threaded or grooved end. UL classified in accordance with NSF-61 for potable water service. Victaulic Style 647

2.6 EXPANSION JOINTS/LOOPS

A. Galvanized steel pipe, Schedule 40, with mechanical couplings, Victaulic 150 Mover

B. Copper Tubing:

1. Use expansion loops where space is available. Size expansion loops as listed in the following table:

Pipe Size	Length of Each Loop	Number of Legs
3/4”	38”	3
1”	40”	3
1-1/4”	42”	3
1-1/2”	46”	3
2”	50”	3
2-1/2”	54”	3
3”	60”	3
4”	68”	3

C. Copper Tubing:

1. Mechanical expansion fittings, size 3/4” thru 4”, copper tube sweat ends, stainless steel laminated internal bellows, 200 psi working pressure, 600°F rated; Keflex Model 7QT.

2. Mechanical expansion fittings, sizes 3/4" thru 4", copper tube sweat ends, stainless steel laminated internal bellows, 175 psig working pressure, 500°F rated, Hyspan Model 8509 or 8510.
3. Allowable length of copper tube per mechanical expansion fitting shall be in accordance with the following table:

System Operating Temperature	Length of Pipe
110°F	300 ft
120°F	275 ft
130°F	250 ft
140°F	225 ft
150°F	175 ft
160°F	175 ft
170°F	150 ft
180°F	140 ft

D. Pre-manufactured expansion loop will be allowed: Metraflex Model MLS Series for sweat ends, MLT Series for threaded ends and MLF Series for flanged or groove ends. Verify pipe size required, laying length, and face-to-face dimension required. Coordinate location with other trades.

2.7 IN-LINE CENTRIFUGAL PUMPS FOR TEMPERATURE MAINTENANCE OF [POTABLE] [LABORATORY] HOT WATER

A. Manufacturers: Armstrong, Aurora, Bell and Gossett, Deming, Ingersoll-Rand, Taco, Weinman, or Worthington

B. Pumps shall be pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 175 psig and operating temperature of 225°F continuous, 250°F intermittent.

C. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

D. Impellers to be single suction enclosed type made of bronze, hydraulically and dynamically balanced, keyed and locked to carbon steel pump shafts and protected by replaceable bronze shaft sleeves.

E. Impellers shall be directly hung form motor shafts without using flexible couplings.

F. Pump shafts shall be high strength carbon steel, sealed and gasketed from pumped fluid.

G. Pumps shall be furnished with mechanical seals of single unbalanced type with rotating element and ceramic stationary seat. Provide spare pump seals for each pump.

H. Bearing assemblies shall have oil lubricated sleeve bearings or regreasable ball bearings.

I. Pump shall be controlled by aquastat located in return pipe at pump with 100°F to 240°F operating temperature with 5°F to 30°F adjustable differential, remote bulb, UL listed similar to Honeywell L6006A1012.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

C. Include connections to plumbing fixtures, to equipment by others, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.

D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Install water piping plumb and square with building. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion.

E. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed.

F. Install shut-off valves where indicated and at base of risers to allow isolation of portions of system for repair.

G. Do not install water piping within exterior walls.

H. Provide drain valves at base of risers and at low points of trapped piping 2” and larger where trapped water volume exceeds 5 gallons.

I. Install pressure reducing valves where indicated on drawings. Provide pressure gauges on both inlet and outlet sides of valve. Flush strainer and adjust to outlet pressure as scheduled.

J. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete.

K. Provide dielectric fittings between dissimilar piping materials.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

M. Install valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to equipment, fixtures and systems installed by others where same requires piping services indicated in this Section.

N. In-line pumps 3 hp and larger shall be independently supported from building structure.

O. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.

P. Install trap filler lines to slope to drain tailpiece without trapping.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried utilities per Section 20 0553.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:

1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
2. Joints shall be cleaned and polished before brazing.
3. Flux of any type shall not be used.
4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.

D. Press Fit Copper Joint:

1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
2. Tubing shall be clean and dry before inserting into fittings.
3. Insert pipe fully into fitting and mark on pipe at shoulder of fitting.
4. Check fitting alignment against mark on pipe to ensure pipe is fully engaged.
5. Crimp joint with pressing tool approved by fitting manufacturer.

3.4 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.5 WATER HAMMER ARRESTORS

A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations, PDI Standards, or as shown on drawings.

B. Use water hammer arrestors with flush valves and quick-closing valves. Provide access panels when water hammer arrestors are installed in non-accessible concealed locations.

3.6 DIELECTRIC UNIONS AND FLANGES

A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.

B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.7 EXPANSION JOINTS

A. Install one anchor on either side of expansion joint, opposite direction of expansion.

B. Install pipe guides on each side of mechanical expansion fittings.

3.8 CLEANING

A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are non-toxic.

3.9 TESTING

A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 100 psi for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not conceal pipe until satisfactorily tested.

E. Testing with air will not be allowed.

3.10 BALANCING

A. Balance water distribution system. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.

B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.11 DISINFECTION

A. Disinfect water piping in the following manner:

1. Clean and flush water pipe with water until water at remote tap is clear.
2. Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 h. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 h.
3. Flush water system of chlorine solution.
4. Allow clean water to stand in system for 24 h. Take sample from remote tap for bacteriological test.

B. Do not use water system for potable water supply until safe bacteriological test is obtained. Repeat steps 1 through 4 until safe water system is obtained.

3.12 BACTERIOLOGICAL TESTS

A. Take representative water samples and test to ensure bacteriologically safe water supply system. Include HPC (Heterotrophic Plate Count) test and test for presence of Pseudomonas aeruginosa as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, make corrections and retest.

B. When connecting to existing water supply of unknown quality, sample for analysis and comparison with finished water system analysis shall be taken prior to making new connection. This will allow isolating source of contamination from within scope of work or pre-existing water supply. Final conditions shall meet criteria specified above for areas within scope of work.

END OF SECTION 221118

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SECTION 221314 - SANITARY WASTE AND STORM DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes materials and methods for sanitary waste and vent, clearwater waste and vent, storm drainage, and overflow storm drainage piping systems within and including piping to 5 ft outside building wall.

1.2 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0520 - Excavation and Backfill

C. Section 20 0529 - Piping and Equipment Supporting Devices

D. Section 20 0549 - Seismic Anchorage and Restraints

E. Section 20 0700 - Mechanical Systems Insulation

F. Section 22 2114 - Plumbing Specialties

G. Section 22 4000 - Plumbing Fixtures

H. Section 26 2913 - Enclosed Controllers

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure material is undamaged and complies with Specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.6 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe and fittings
2. Joints
3. Cleanouts
4. Floor drains and floor sinks
5. Roof drains
6. Downspout nozzles
7. Air gap fittings
8. Discharge check valves
9. Discharge isolation valves
10. Traps
11. Sump pumps

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.2 PIPE, FITTINGS, AND JOINTS

A. Interior Underground 15” and Smaller:

1. Polyvinyl Chloride (PVC):
   a. Pipe:
      1). Schedule 40, Class 12454-B (PVC 1120), ASTM D1785
   b. Fittings: Socket fitting, DWV patterns, ASTM D3311. Fabricated fittings 10” and larger shall be per ASTM F1866.
   c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

B. Interior Above Ground:

1. Polyvinyl Chloride (PVC):

a. Pipe: Schedule 40, Class 12454 (PVC 1120), ASTM D1785

b. Fittings: Drain, waste and vent (DWV) pattern fittings, ASTM D2665; socket fitting patterns, ASTM D3311. Fabricated fittings 10” and larger shall be per ASTM F1866.

c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564

~~1. Cast Iron:~~
   ~~a. Pipe: Hubless cast iron pipe, ASTM A-888, CISPI 301, NSF certified with material test reports from marked with collective trademark of Cast Iron Soil Pipe Institute or receive prior approval by Engineer~~
   ~~b. Fittings: Hubless cast iron fittings, ASTM A-888, CISPI 301, NSF certified with material test reports from marked with collective trademark of Cast Iron Soil Pipe Institute or receive prior approval by Engineer~~
   ~~c. Joints: Heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540, Mission Heavyweight, Husky Series 4000, Ideal Tridon “HD”, or Clamp-All Hi-Torq 125~~

2. Copper:
   a. Pipe: Type M copper tube, ASTM B88
   b. Fittings:
      1). Cast copper drainage fittings (DWV), ANSI B16.23
      2). Wrought copper drainage fittings (DWV), ANSI B16.29
   c. Joints: Lead free (<0.2%) solder, ASTM B32; flux, ASTM B813

C. Pressurized Interior Above Ground:

1. Copper (2" and smaller):
   a. Pipe: Type L copper tube, hard drawn temper, ASTM B88
   b. Fittings:
      1). Cast copper drainage fittings (DWV), ANSI B16.23
      2). Wrought copper drainage fittings (DWV), ANSI B16.29
   c. Joints: Lead free (<0.2%) solder, ASTM B32; flux, ASTM B813

2. Copper (3" and larger):
   a. Pipe: Type L copper tube, hard drawn temper, ASTM B88
   b. Fittings:
      1). Wrought copper, ASTM B75 or ASTM B152, ASME B16.22, roll grooved
      2). Copper alloy CDA 836*85-5-5-5), sand cast per ASTM B584 and ASME B16.18, roll grooved
   c. Joints: Roll grooved with ductile iron couplings, ASTM A536. Heat-treated carbon steel bolts, ASTM A183, EPDM gasket and enamel coated. Victaulic Style 606.

2.3 VALVES

A. Pump Discharge Check Valves:

1. Acceptable Manufacturers: Hammond, Milwaukee, Nibco and Stockham with indicated features and equal to model listed
2. Size 2" to 4", Horizontal Installation:
   a. Cast iron body, swing check, bronze disc and ring, brass pin, Class 125, threaded ends, Nibco T-918-B

3. Size 2-1/2" and Larger, Vertical Installation:
   a. Cast iron body, swing check, bronze disc to 4" and cast iron disc with bronze disc face rings or bronze disc for 5" and up, lever and spring operator, brass pin, Class 125, flanged ends, Nibco F-918-BLS

B. Pump Discharge Isolation Valves:

1. Ball Valves:
   a. Acceptable Manufacturers: Apollo, Hammond and Nibco with indicated features and equal to model listed
   b. Size 2" to 3":
      1). Full Port, 2 Piece: Bronze body, ASTM B584, stainless steel ball, teflon seats, stem extension, 600 psi CWP pressure rating, ~~**[Apollo Series 77-240] [Hammond Series 8303/8513] [**~~Nibco 585-70-66~~**]**~~

2.4 CLEANOUTS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in Drains and Cleanout Schedule.

B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper-thread plug with Teflon tape thread wrap.

C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, equal to J.R. Smith 4033L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C.

D. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover, equal to J.R. Smith 4472T.

2.5 FLOOR DRAINS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed herein or in Drains and Cleanout Schedule.

B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

C. FD-1: Cast iron body with round 5” diameter stainless steel strainer. Include trap primer connection where indicated on drawings. J.R. Smith 2005Y-SS

D. FD-2: Cast iron body with round 8” diameter satin nickel bronze strainer. Include trap primer connection where indicated on drawings. J.R. Smith 2005Y-A.

2.6 FLOOR SINKS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed herein or in Cleanouts and Drain Schedule.

B. Floor sink shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Double drainage pattern floor sink shall have anchoring and seepage flanged for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.

C. FS-1: ~~Type 304 stainless steel, 14 ga, with #4 satin finish interior, 6” deep, 1/2” trap primer tapping, and with medium duty stainless steel "heelproof" grate, 1/4” square openings, for medium traffic areas. J.R. Smith 9692Y-P050-61~~**Acid resistant coated non-traffic tops, 8” square top, acid resistant coated cast iron grate, aluminum dome strainer, flashing clamp**. **J. R. Smith 3410-P050**

2.7 ROOF DRAINS AND OVERFLOW DRAINS

A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number listed in **Cleanouts and Drain** Schedule

B. Roof drains and overflow drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10” diameter cast iron dome strainer, and cast iron underdeck clamp. J.R. Smith 1010Y-RC-CID.

C. Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket. J.R. Smith 1710.

2.8 AIR GAP FITTINGS

A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice the inlet area. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to J.R. Smith 3950 or 3951.

2.9 DOWNSPOUT NOZZLES

A. Acceptable Manufacturers: Josam, Smith, Wade or Zurn equal to number listed

B. Downspout nozzles shall be polished Type 304 stainless steel, hinged cover, wall flange and threaded inlet, equal to J.R. Smith #1775.

2.10 TRAPS

A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 4000 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.11 ELEVATOR SUMP PUMPS

A. Acceptable manufacturers: Aurora/Hydromatic; Liberty, Stancor, Inc., Weil

B. Pump shall be submersible type constructed of epoxy coated cast iron shell, cast iron volute, two vane enclosed semi-open non-clog bronze impeller, stainless steel shaft, stainless steel fasteners, upper sleeve and lower ball bearing factory sealed grease lubricated, and ceramic mechanical seal.

C. Pump shall be hermetically sealed, capacitor start, built-in thermal overload protection sized for no-overloading entire pump curve.

D. Pump shall be of capacity and electrical service as indicated in the equipment schedules on the drawings.

E. Pump controls shall include:

1. Single on/off UL listed float switch
2. Oil sensor to terminate operation on oil
3. Alarm with dry contact to BAS

F. Pump accessories shall include:

1. Discharge check valve
2. Full port ball valve
3. Union for each pump

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.

B. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

C. Grade horizontal lines with minimum of 1/8” per ft, except piping 2” diameter or smaller which shall be run at 1/4” per ft slope.

D. Grade horizontal lines with minimum of 1/4” per ft, except piping 4” diameter or larger which may be run at 1/8” per ft slope with approval of local authority.

E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.

F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.

G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

H. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.

I. Maintain piping in clean condition internally during construction.

J. Mitered ells, notched tees, and orange peel reducers are not allowed. Bushings are not allowed on threaded piping.

K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.

L. Set cleanouts true and level and protect properly throughout construction.

M. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.

N. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris and other foreign matter from entering before use. Locate running traps for full accessibility with double cleanout.

O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried sewers per Section 20 0553.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer’s recommendations when heating valves and equipment for soldered connections.

3.4 POLYVINYL CHLORIDE (PVC) PIPE

A. Pipe Joints:

1. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if fitted with wheels designed for use with PVC pipe that do not leave raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Check dry fit of pipe and fittings. Reject materials, which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.
2. Maintain pipe, fittings, primer and cement between 40°F and 100°F during application and curing. Apply primer and solvent using separate daubers (3” and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter. Apply primer to fitting socket and pipe surface with scrubbing motion. Check for penetration and reapply as needed to dissolve surface to depth of 4-5 thousandths. Apply solvent cement to fitting socket and pipe in amount greater than needed to fill gap. While both surfaces are wet, insert pipe into socket fitting with quarter turn to bottom of socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4” and larger. Hold joint for 30 seconds or until set, whichever is longer. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing.

B. Install plastic pipe and fittings as recommended by manufacturer. Include adequate offsets or expansion joints to allow for pipe expansion.

C. Do not install plastic pipe in plenum space.

~~3.5 CAST IRON PIPE~~

~~A. No-hub Piping: Place gasket on end of one pipe of fitting and clamp assembly on end of other pipe or fitting. Firmly seat pipe or fittings ends against integrally molded shoulder inside neoprene gasket. Slide clamp assembly into position over gasket. Tighten fasteners to manufacturer's recommended torque.~~

~~B. Install cast iron pipe and fittings as recommended by CISPI in their publication "Installation of Cast Iron Soil Pipe and Fittings".~~

~~C. Support piping at every coupling. Locate hanger within 18" of coupling.~~

~~D. Installations with multiple joints within a 4 ft developed length shall be supported at every second joint.~~

~~E. Secure base of risers with thrust restraints to prevent joint separation. Restraint shall be in accordance with CISPI recommendations.~~

~~F. Brace horizontal piping 5" and larger to prevent horizontal movement. Install bracing at every branch connection and every change of direction in accordance with CISPI recommendations.~~

~~3.6 TESTING~~

~~A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.~~

~~B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.~~

~~C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.~~

~~D. Do not backfill pipe until successfully tested.~~

~~E. Testing with air will not be allowed.~~

END OF SECTION 221314

SECTION 221500 - INDUSTRIAL COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers piping and equipment required to provide industrial grade compressed air at 40°F dewpoint at 100 psi system pressure as shown on plans and details.

1.2 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0529 - Piping and Equipment Supporting Devices

~~C. Section 20 0549 - Seismic Anchorage Restraints~~

~~D.~~**C.** Section 22 2114 - Plumbing Specialties

~~E.~~**D.** Section 22 4014 - Equipment by Others

~~F.~~**E.** Section 23 0550 - Vibration Isolation

~~G.~~**F.** Section 26 2913 - Enclosed Controllers

~~**1.3 [REFERENCE**~~

~~A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]~~

~~1.4~~1.3 SUBMITTALS

A. Shop drawings on items specified herein.

~~1.5~~1.4 PRODUCT DELIVERY

A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.

B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 PIPE AND FITTINGS

A. Copper

1. Pipe:
   a. Copper tube, Type L, hard temper, ASTM B88
   b. Copper tube, Type L, hard temper, ASTM B280

2. Fittings:
   a. Wrought copper or bronze, solder joint, pressure rated, ANSI B16.22
   b. Cast copper alloy, solder joint, pressure rated, ANSI B16.18

3. Joints:
   a. 3” and smaller: Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32; flux, ASTM B813
   b. 4” and larger: Brazed, BCuP-3 or BCuP-5 type, AWS A5.8, 1250°F melting point minimum. Impurities shall not exceed 0.15%

4. Unions
   a. 3” and smaller: Wrought copper union, Nibco 633-W
   b. 4” and larger: Cast red brass flanges, alloy 844, ASTM B584, Class 150, ANSI B16.24 with neoprene gasket.

2.3 SHUTOFF VALVES

A. Ball Valves

1. Acceptable Manufacturers: Nibco, Apollo and Watts, subject to providing valves equal to item specified
2. Size 3” and Smaller:
   a. Full port, 2-piece, bronze body, chrome plated bronze ball, teflon seats, blowout-proof stem, threaded or soldered joint, Watts FBV or FBVS
   b. Full port, 3-piece, bronze body, stainless steel ball, teflon seats, stainless steel trim, blow-out proof stem, 600 psi CWP; Nibco S- or T-595-6-66 Series through 2-1/2”
   c. Conventional port, 3-piece, bronze body, stainless steel ball, teflon seats, blow-out proof stem, stainless steel trim, 600 psi CWP; Nibco T- or S-590-Y-66 Series through 3”
   d. Conventional port, 3-piece, carbon steel body, stainless steel ball, blow-out proof stem, teflon seats and seals, 1500 psi CWP rating; Nibco T-590-CS-R-66-LL
   e. Conventional port, 2-piece, carbon steel body, stainless steel ball, blow-out proof stem, teflon seats and seals, 1500 psi CWP rating; Nibco T-580-CS-R-66-LL

3. Size 2” and smaller for Lock-out/Tag-out
   a. Conventional port, 2-piece, bronze body, stainless steel ball, teflon seats, stainless steel trim, blow-out proof stem, pad locking handle in closed position, automatic venting of downstream pressure in closed position, 600 psi CWP; Apollo 75-140-41

B. Butterfly Valves

1. Acceptable Manufacturers: Bray, DeZurik, Keystone, Nibco, Stockham, or Keystone, subject to providing valves equal to item specified
   a. Size 2” and Larger: Lug pattern, ductile iron body, aluminum-bronze or nickel-plated ductile iron disk, stainless steel shaft, EPDM molded-in liner, upper thrust bearing, 200 psi working pressure rating, compatible with ANSI B16.1, Class 150 flanges, suitable for dead end service with no downstream flange/piping attached. Lever operator through 4”, gear operator 5” and larger. Provide adjustable memory stop and locking device.
   b. Size 4” and Larger: Lug design, 150 lb class, ANSI B16.1 compatible, nylon coated cast iron body, stainless steel shaft and disk, teflon seats and seals, bronze bushings; Bray Series 31 with gear operator thru 4” pneumatic operator for 5” and larger

2.4 CHECK VALVES

A. Spring loaded, bronze or bronze/stainless steel body, 316 stainless steel spring, and straight through flow. Apollo Ball-Cone Model 62-100-57.

2.5 PRESSURE REGULATORS

A. Acceptable Manufacturers: Cashco, Fisher, Jordan or approved equal

B. **Bronze** body and spring case, direct acting valve, manual adjustment screw with top nut, stainless steel trim, resilient valve seat. Valve shall be capable of XXX cfm with outlet pressure of XXX psig with inlet pressure of XXX psig Refer to schedule on drawings for performance criteria.

2.6 AUTOMATIC DRAIN DEVICE

A. Acceptable Manufacturers: Jorc or approved equal

B. Automatic condensate removal device with zero air loss during condensate discharge. Drain device shall have Viton seals and shall have 120V power connection.

C. Basis of Design is Jorc “Smart Guard Ultra” capable of up to 3600 scfm at up to 230 psig at 34-112°F

~~2.7 OIL-FREE RECIPROCATING AIR COMPRESSOR (AC-XX)~~

~~A. Manufacturers: **Powerex,** Atlas Copco, Champion, Ingersoll-Rand, Joy, or Quincy~~

~~B. Air compressor[s] shall be [simplex] [duplex] [triplex] [**,** air cooled] [water cooled], [single stage] [two stage], oil free reciprocating unit[s] [piped in parallel]. Compressor[s] shall be [base mounted] [tank mounted] and shall be factory wired, piped and tested prior to delivery to jobsite.~~

~~C. Compressors shall operate in lead/lag/alternate configuration. **Premium control** Panel**package** for compressor control shall be included with package.~~

~~D. Each compressor shall be provided with following components:~~

~~**6” color touch-screen**~~
~~1. 10 **µm(**micron**)** inlet filter~~
~~2. Air intake silencer~~
~~3. Discharge air check valve~~
~~4. Manual compressor isolation valve~~
~~5. [Air] [Water] cooled aftercooler~~
~~6. [200] [230] [460] V, 3 Ph motor meeting efficiencies listed in Section 20 0513 - Motors~~
~~7. [Simplex] [Duplex] [Triplex] control panel shall be NEMA 4 rated enclosure with gauges, controls and indicators to monitor the following operations:~~
~~a. [1] [2] [3] magnetic across-the-line starters with thermal overload protection~~
~~b. Automatic alternator with three-position switch~~
~~c. 120 V control transformer~~
~~d. Compressor discharge pressure gauge~~
~~e. Power indicator~~
~~f. High temperature shutdown switch~~
~~g. Hand-off-auto switch~~
~~h. Motor overload alarm~~
~~i. Run time meters for each compressor~~

~~j. Extra set of dry contacts for general alarm signal to building automation system~~

~~**Select air or water cooled aftercooler. Specify capacity in equipment schedule on drawings. Select number of compressors in package. Provide automatic alternator option only when multiple compressors are specified. Verify necessity of extra contacts for BAS monitoring.**~~

~~E. Manufacturers: Atlas Copco, Champion, Ingersol-Rand, Joy, or Quincy~~

~~2.~~2.7 OIL-LESS ROTARY SCREW AIR COMPRESSOR (AC-~~XX~~**1**)

A. Manufacturers: **Powerex,** Atlas Copco, Ingersoll-Rand, Kobolco, or Quincy

B. Air compressor[s] shall be ~~**[simplex] [duplex]**~~ ~~[~~triplex~~]~~, ~~[~~air cooled~~**] [water cooled]**~~, ~~[~~single stage~~]~~ ~~[two stage]~~, oil less rotary screw unit[s] ~~[piped in parallel]~~. Compressor[s] shall be base mounted ~~[~~on frames with forklift slots~~][within sound enclosure]~~. Compressor[s] shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air compressor enclosure shall include vibration isolation meeting requirements of Section 23 0550 - Vibration Isolation. If enclosure can not meet requirements of Section 23 0550, enclosure shall be provided with external isolators. Vibration isolators shall not be installed in series.

D. Compressors shall operate in lead/lag/alternate configuration. Panel for compressor control shall be included with package.

E. Each compressor shall be provided with following components:

1. 10 **µm(**micron~~)~~ inlet filter
2. Air intake silencer
3. Compressor unloading valve
4. Discharge air check valve
5. Manual compressor isolation valve
6. ~~[~~Air~~]~~ **[Water]** cooled aftercooler
7. Discharge air/water separator
8. ~~**[200] [230]**~~ ~~[~~460~~]~~ V, 3 Ph motor meeting efficiencies listed in Section 20 0513 - Motors
9. Capacity of ~~XXX~~ **73.5** ~~L/s~~(cfm~~)~~ at ~~[XXX]~~**145** ~~kPa~~(psig~~)~~
10. Compressor control panel shall be NEMA 4 rated enclosure with gauges, controls and indicators to monitor the following operations:
    a. Magnetic across-the-line starters with thermal overload protection
    b. Control functionality to start and stop multiple compressors in lead-lag-alternate sequence. Each compressor shall be capable of being master control machine.
    c. 120 V control transformer
    d. Intercooler pressure
    e. Compressor discharge pressure gauge
    f. ~~**[**~~Air~~]~~ ~~[Water]~~ cooled aftercooler
    g. First ~~[**and second]**~~ stage outlet air temperature
    h. High first ~~[**and second]**~~ stage outlet air temperature alarm
    i. High temperature shut-down switch
    j. Power indicator
    k. Run time hour indicator
    l. Hand-off-auto switch
    m. Motor overload alarm
    n. Extra set of dry contacts for general alarm signal to building automation system

~~2.9~~2.8 AIR RECEIVER (T-2)

A. Manufacturers: Powerex, Adamson, Brunner or approved equal

B. Air receiver shall be an ASME rated vertical vessel. Receiver shall have the following components:

1. 200 gal capacity
2. 150 psig rated maximum working pressure
3. Maximum dimensions of 30“ diameter and 76“ height excluding base
4. Ring base with access hand holes
5. Inlet and outlet pressure gauges
6. Safety relief valve with soft seat
7. Automatic drain device
8. Outlet pressure regulating valve
9. Epoxy coated interior

~~2.10~~2.9 REFRIGERATED AIR DRYER (RD-01)

A. Manufacturers: Powerex, Arrow by McIntire, Deltech, Hankinson, or Zeks

B. Air dryers shall be refrigerated units piped in parallel. Air dryers shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air dryer**s** shall be provided with following components:

1. Duplex inlet coalescing filters with automatic drain device
2. Duplex outlet particulate filters
3. Hot gas bypass
4. Air cooled condensing unit
5. Capacity of 75 scfm at 40°F dew point discharge air
6. 120 V, 1 Ph power connection
7. NEMA 4 rated control panel with following features:
   a. Power indicator
   b. Compressor on indicator
   c. High air temperature alarm
   d. Locally mounted dewpoint indicator
   e. High humidity alarm
   f. Extra set of dry contacts for alarm monitoring to building automation system

PART 3 - EXECUTION

3.1 GENERAL

A. Copper pipe with soldered joints shall be limited to piping 4” and smaller or when system pressure is less than 20 psig.

B. Copper pipe with brazed joints shall be used when piping is larger than 4” and when system pressure is 20 psig or greater.

C. Steel pipe system with threaded joints may be used for any size and system pressures of 150 psig or less.

3.2 INSTALLATION

A. Install compressed air piping as shown on drawings and details. Slope piping to drain to low point.

B. Provide flexible connections at compressor inlet and outlet connection points as shown on details.

C. Keep piping capped during construction to prevent intrusion of construction debris.

D. Support piping drops through finished ceiling from structure above to prevent lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or workbenches using appropriate hangers, anchors, or Unistrut.

E. Install unions on equipment side of shutoff valves for items such as: air dryers, receiver, compressors, filters, and similar equipment requiring periodic replacement or maintenance.

F. Install vented valve for lock-out/tag-out at connection to equipment. Vented valve shall meet OSHA requirements for disabling power source and bleeding downstream energy.

G. Where ball valves are used, provide pneumatic or electric valve actuator and related accessories, compatible with valve specified.

H. Install temporary plugs and caps on openings during construction phase.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:

1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
2. Joints shall be cleaned and polished before brazing.
3. Flux of any type shall not be used.
4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.

3.4 COMPRESSOR

A. Air compressor package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer's recommendations. Consult manufacturer-furnished piping diagrams for interconnecting piping of system components.

B. Installation shall be inspected and approved by manufacturer's field representative. Equipment start-up shall be performed by manufacturer's representative in presence of Owner's representative.

C. Provide wiring necessary for controls and automation systems interface.

3.5 TESTING

A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Air piping shall be tested at 150 psig for 24 h. Soap test each joint to detect leaks during test period. No loss of pressure allowed during test period. Defective joints shall be cut out and replaced.

C. Air compressor equipment shall be delivered pre-assembled and tested by equipment manufacturer.

D. Verify proper signal transmission for each condition specified to Building Automation Controller.

3.6 CLEANING

A. Before system is placed in use, flush piping with product air to remove foreign particles.

3.7 WARRANTY

A. Manufacturer shall warrant air compressor package and components complete, for period of 2 yrs from date of start-up.

END OF SECTION 221500

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SECTION 221600 - NATURAL GAS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies natural gas piping and accessories to 5 ft outside building wall.

1.2 RELATED WORK

A. Section 20 0520 - Excavation and Backfill

B. Section 20 0529 - Piping and Equipment Supporting Devices

C. Section 20 0553 - Mechanical Systems Identification

D. Division 26 - Electrical

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to insure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Off-site storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.6 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe and fittings
2. Joints
3. Valves
4. Valve boxes
5. Seismic Shutoff Valves

6. Regulators

B. Shop Drawings on items specified herein.

1.7 NATURAL GAS SERVICE

A. Contact local gas company for cost of gas service to building, including pressure reducing valves, if required, and gas meter. Include this cost in Bid.

B. All charges for gas service as shown on drawings including connection from main in street or other location to gas meter shall be paid by this Contractor. This includes setting of gas meter and work performed by Gas Company.

C. Gas service, meters and regulating equipment will be installed by gas company on inlet side of meters.

D. Cost of gas service, meters and regulating equipment to inlet side of meters will be paid by Gas Company.

E. Include cost of alterations of existing gas service, meters and reducing valves in Base Bid. This includes work performed by Gas Company to, and including, gas meters.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

B. Anodeless Gas Riser:

1. Acceptable manufacturers: Elster Perfection, Gastite, Georg Fischer, Lyall, or approved equal
2. Manufactured polyethylene to carbon steel transition fitting, requiring no cathodic protection for buried carbon steel pipe, socket, or butt fusion connection for polyethylene pipe, plain beveled end for carbon steel pipe, electrostatically applied epoxy coating on carbon steel pipe, CSA listed

2.2 ABOVE GROUND PIPE, FITTINGS AND JOINTS (UNDER 2 PSIG)

Note: all-natural gas piping shall have welded joints due to plenum return on HVAC systems

A. 2” and Smaller:

1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded
3. Joints: Welded

B. 2-1/2 and Larger:

1. Pipe: ASTM A53, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded
3. Joints: Welded

2.3 ABOVE GROUND PIPE, FITTINGS AND JOINTS (OVER 2 PSIG)

Note: All-natural gas piping and associated valving routed within the return air plenum shall have welded joints.

A. 2” and Smaller:

1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A105/ANSI B16.11, 3000 lb forged steel, socket weld
3. Joints: Welded

B. 2-1/2” and Larger:

1. Pipe: ASTM A53, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel
2. Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded
3. Joints: Welded

2.4 UNIONS

A. Steel Pipe, 2” and Smaller:

1. Malleable iron, ground brass seat, 150 psi steam working pressure; Stockham Figure 694 or equivalent
2. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5

2.5 VALVES

A. Ball Valves:

1. Acceptable Manufacturers: Neles-Jamesbury, Apollo, Kerotest, Nibco and Watts equal to manufacturer's Figure number listed
2. 2” and Smaller:
   a. Bronze body, threaded, quarter turn, chrome plated brass ball, large port, reinforced TFE seat and stem packing, blowout-proof stem, 250 psig LP-Gas, UL Listed, CSA certified. Apollo 50 GB series.
   b. Carbon steel body, threaded, quarter turn, 2 piece design, 316 stainless steel ball and stem, full port, spiral wound 316 stainless steel and teflon seats and seals, blowout proof stem, 800 psi CWP rated, lever handle, CSA certified. Jamesbury Fire-Tite, Series 2000 Style 23-22
   c. Carbon steel body, quarter turn, 3 piece design, chrome plated steel ball, full port, TFE seats and seals, blowout proof stem,1000 psi CWP, lever handle, CSA certified. Jamesbury Fire-Tite, Series 4000.
3. 2-1/2” through 8”:
   a. Carbon steel body, ASTM A216-WCB Class 150, quarter turn, carbon steel flanged ends, Type 316 stainless steel ball, stainless steel stem, PTFE seats and seals, API-6D test requirement. Apollo 88A-140-35-59-TD

B. Plug Valves:

1. Acceptable Manufacturers: DeZurik, Homestead, Key Port, Milliken and Resun equal to manufacturer's Figure number listed

2. 2” and Smaller:
   a. Cast iron body, threaded, permanently lubricated bearings, bronze plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi CWP, UL Listed. Key Port Figure 425S.

3. 2-1/2” through 4”:
   a. Cast iron body, flanged, permanently lubricated bearings, electroless nickel plated cast iron plug, corrosion resistant Hycar plug seal, Buna stem seal packing, lever actuator, 175 psi CWP, UL Listed. Key Port Figure 425F.

4. 5” and Larger:
   a. Cast iron body, flanged, stainless steel bearings, resilient faced plugs, totally enclosed hand wheel actuators, 200 psi CWP. Resun Model R-1431.
   b. Actuator shall be sized based on maximum pressure differential across valve.

C. Vented Gas Pressure Regulators:

1. Acceptable Manufacturers: Fisher, Rockwell, Sensus, or American meeting capacity and performance as scheduled
2. 2” and Smaller Venting: Cast iron body, aluminum spring case, plated steel spring, Nitrile diaphragm and disc, threaded, vent to exterior of building, 150 psi CWP, -20°F to 160°F, listed in compliance with ANSI Z21.80, Fisher S200 seriesValve shall be capable of XXX cfh with an inlet pressure of [XXX] [in WC] [psig] and an outlet pressure of [XXX] [in WC] [psig].

2.6 VALVE BOXES

A. Acceptable Manufacturers: Acorn, Acudor, or approved equal

B. Valve Box: Acudor ARVB, recessed wall mounted, 12” by 12” by 4” size, 16 ga stainless steel construction, continuous concealed piano hinge, lever latch or slide latch, #4 satin polish finish, holes for piping penetration

C. Valves: Ball valves as specified above, with lever handles, easily operated without tools.

D. Identification: Engraved plastic plate, “NATURAL GAS SHUTOFF VALVE”. Refer to Section 20 0553.

2.7 SEISMIC GAS SHUTOFF VALVE

A. Valve shall have manual reset, selected with minimum pressure drop based on 7” WC, positive closure, soft seal seating, visual open-close indicator and UL Certified.

B. Valve shall close within 5 seconds when subjected to horizontal, sinusoidal oscillation at peak acceleration of 0.3 G for period of 0.4 seconds.

C. Valve shall not close when subjected for 5 seconds to each of the listed horizontal, sinusoidal oscillations as follows:

Peak Acceleration	Period
0.4 G	0.1 seconds
0.08 G	0.4 seconds
0.08 FG	1.0 seconds

D. Valve shall be either threaded or flanged selected at maximum capacity with minimal pressure drop.

E. Manufacturers:

1. Koso/California Valves, Tremble Tech Inc., Safe-T-Quake or equal
2. The following are options available only on Koso/California Valves:
   a. Maximum pressure: 0.5 psi, 7 psi, 20 psi, and 60 psi
   b. Flanged ends: 2”, 3”, 4”, and 6”
   c. Three way valve (seismic shut-off for pneumatic controls. Dry air or Nitrogen ONLY)
   d. Electrical switch (seismic shut-off for electrical circuits)
   e. Remote actuator (use with panic switch, smoke/fire alarm)

2.8 CATHODIC PROTECTION

A. Provide complete galvanic anode type cathodic protection system for underground steel gas piping, including devices to electrically isolate system being protected.

B. Corrosion protection system shall be provided by Contractor regularly engaged in installation and testing of cathodic protection systems. Contractor's personnel shall be experienced and shall be supervised by Engineer who is accredited as Corrosion Specialist by National Association of Corrosion Engineers. Calculations, design and testing shall be performed by Corrosion Specialist. Procedures shall conform to NACE Standards.

C. Submit catalog cuts and shop drawings for the following:

1. Anodes
2. Permanent Reference Cells
3. Cable and wire
4. Test stations
5. Terminal boxes
6. Isolating flanges, unions, coatings, easing seals
7. Exothermic welding devices
8. Layout drawings, wiring diagrams
9. Test instruments
10. Dielectric tape
11. Test connection points
12. Accreditation of Corrosion Specialists by National Association of Corrosion Engineers
13. Calculations from field survey, performed by Corrosion Specialist

D. Foreign Metallic Contacts:

1. No foreign metal shall be allowed to contact electrically isolated sections of pipe between flange insulators. Where pipe passes through building walls, manholes, valve pits, etc., caution shall be exercised to ensure that pipe does not contact reinforcing steel. Pipe anchors and supports shall not be permitted in contact with metallic structures. Flange insulators shall be placed as close as possible to building and manhole entrances to avoid shorting to other metallic members.

2. Upon completion of installation, system shall be tested to ensure system performance. One year service agreement shall be included in base price. Cathodic protection system must be certified by NACE Accredited Corrosion Specialist.

E. Field Quality Control:

1. Provide system with calculated design life exceeding 40 yrs.
2. Corrosion Specialist shall perform soil resistivity survey. Survey shall include entire length of proposed right-of-way. Soil survey shall include soil pH and presence of chlorides. Stray current investigation shall also be conducted prior to cathodic protection design.
3. Corrosion Specialist shall provide engineering calculations to verify design of system. Calculations shall follow format published by recognized corrosion expert.
4. Corrosion Specialist shall inspect work at least twice to ascertain that there is no grounding, short circuits, coating damage, and that installation is in accordance with standards and methods specified herein.

PART 3 - EXECUTION

3.1 GENERAL

A. Install gas piping according to requirements of this Section, local gas utility, NFPA 54 National Fuel Gas Code, AGA pamphlets and as shown on drawings.

B. Piping through roof to be run through approved roof penetration with flashing and counter flashing.

C. Install buried/underground polyethylene gas piping with trace wire taped to pipe along its entire route. Secure wire to pipe to prevent movement during backfilling. Extend trace wire to valve boxes and service entrance.

D. Transition from polyethylene piping to steel piping shall occur below grade. Provide cathodic protection and corrosion protection pipe wrap for underground steel pipe.

E. Install underground polyethylene gas piping exterior to building according to pipe manufacturer's recommendations and to meet local gas utility company's installation standards.

F. Manufacturer's representative shall instruct workmen in proper techniques for installation of underground polyethylene gas piping and provide certification to Owner that instructions have been given and proficiency been demonstrated by Contractor for installation of that piping system. Joints must be made by "Qualified" personnel proficient in joining methods of ASTM D2513 thermoplastic gas pressure pipe.

G. Grounding to gas piping is prohibited.

H. Gas piping shall be installed with dirt legs adjacent to equipment and with drain tees and plugs at low points.

I. Gas piping in plenum ceilings shall have welded joints.

J. Pitch horizontal piping downward at 1” per 60 ft in direction of flow toward risers or appliances. Install minimum of 4” deep dirt leg at bottom of each vertical run and at each appliance. When installing mains and branches, cap gastight each tee or pipe end, which will not be immediately extended. Take branch connections to main from top or side of main.

K. Coat underground piping with corrosion resistant tape equal to Tapecoat H-30 and cathodically protected as specified herein. Repair breaks in tape coating caused by installation process.

L. Make threaded joints by cutting pipe square and reaming inside. Threads shall be cut so exposed threads do not exceed 3 in number. Protect exposed threads against corrosion. Use only joint compounds approved for gas piping.

M. Seismic shut-off valve must be installed upright, level, plumb, and downstream of regulator or main gas meter (prior to structure it protects). Valve must be rigidly mounted to earth foundation or structure so that seismic movements will be transmitted to acceleration trigger mechanism within valve assembly.

N. Do not exceed maximum torque (inch-pounds) specified by valve Manufacturer during installation of seismic shut-off valve.

O. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried gas lines per Section 20 0553.

3.3 PRESSURE REGULATORS

A. Install regulators in accordance with manufacturer's instructions.

B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from structure by brackets and supports.

C. Vent(s) from vented pressure regulators or pressure safety valves shall be piped to outside. Terminate vent with protection screen and return bend. If above ground vent terminates in area subject to snow accumulation, terminate line at least 5 ft above grade. Coordinate vent routing with other trades to point of termination. Size vents in accordance with regulator manufacturer's requirements for regulator flow rate and length of run.

D. Provide unions on both sides of regulators for removal and maintenance.

E. Provide gas cock for pressure verification.

3.4 VALVE BOXES:

A. Mount bottom of box at 60” above finished floor. Adjust height as required to match wall material pattern.

B. Orient valve to allow closing the door when valve is both open and closed.

C. Seal pipe penetrations with silicone caulk.

D. Mount identification placard onto valve box door.

3.5 CONNECTIONS

A. Provide appliance connectors at ranges, ovens and other appliances, which require that they be relocated before accessing gas connection. Do not use appliance connectors for water heaters

or for other equipment or appliances, which do not require that they be relocated before accessing gas connection.

B. Install shut off valve at each appliance. Provide valved connection at main for equipment and appliances furnished by others.

C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from equipment. Provide shutoff valves at each piece of equipment.

3.6 WELDER QUALIFICATIONS

A. Welding procedures, welders, and welding operators for building service piping to be in accordance with certified welding procedures of National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing.

B. Before metallic welding is performed, submit Welding Procedure Specification together with Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.

C. Before polyethylene fusion welding is performed, submit certification that welders to be used on this project have successfully demonstrated proper welding procedures in accordance with Code of Federal Regulations, Title 49, Part 192, Section 192.285.

D. Before welding is performed, submit Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.

E. Welded joints shall be made in conformance with latest provision of Code for Pressure Piping, ANSI Standard B31-8 - Gas Transmission and Distribution Systems. Welds to be made by qualified welders experienced in piping work. Welding, piping fabrication, etc. shall be in accordance with ASME Code, State Codes, and Welding Manual of Mechanical Contractors Association of America.

F. Architect or Engineer reserves right to test work of welder employed on Project, at Contractor's/Owner's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project and defective welds replaced at no additional cost to Owner.

3.7 TESTING

A. Test above ground steel gas piping with dry compressed air at 50 psi for 2 h. Soap test of each joint shall be done to detect leaks during 2 h period. No loss of pressure allowed during test period. No piping shall be concealed until successfully tested.

B. Test underground polyethylene gas piping at 50 psi with dry air for 2 h. No loss in pressure allowed. Defective joints shall be cut out, pipe repaired, and retested. No piping may be backfilled until successfully tested.

C. Types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, degree of examination, and basis for rejection shall be matter of prior written agreement between fabricator, or Contractor and purchaser.

D. Local regulating and governing agencies may require periodic testing of seismic valve's ability to shut-off gas flow during seismic event. Follow procedures specified by local governing agency for test.

3.8 CLEANING

A. Before actuation of gas system, flush system with dry nitrogen to ensure clean system free of oil and construction debris.

END OF SECTION 221600

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SECTION 222114 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers material specialties for piping systems.

B. All components installed on water systems defined in Section 22 1118 shall comply with NSF-372 to be compliant with requirement for lead content of <0.25% maximum weighted average.

1.2 RELATED WORK

A. Section 22 0594 - Domestic Water Systems Balance

B. Section 22 1118 - Water Distribution System

C. Section 22 1314 - Sanitary Waste and Storm Drainage Systems

D. Section 22 1500 - Industrial Compressed Air System

E. Section 22 6114 - Laboratory Compressed Air System

F. Section 22 6214 - Laboratory Vacuum Piping System

G. Section 22 6653 - Corrosion Resistant Waste and Vent System

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements**.**

1.4 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Thermometers
2. Pressure gauges
3. Pressure relief valves
4. Strainers
5. Backflow preventers
6. Flexible connections
7. Air vents
8. Trap primers
9. In-line check valves
10. Flashings
11. Safings

B. Shop drawings on items specified herein.

C. Certificates: Submit performance testing certificates for reduced pressure backflow preventers and double check backflow preventers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 THERMOMETERS

A. Manufacturers: Miljoco, Taylor, Trerice, Weksler, Winters and Weiss equal to Trerice number listed

B. Thermometers shall be 9” die cast aluminum case and frame, double strength glass window, adjustable angle stem, permanently stabilized glass tube with mercury free indicating fluid, readable scale with gradations from 30°F to 240°F. Provide brass extension neck sockets of appropriate length. Trerice Series No. A400 (old catalog number BX91400).

C. Thermometers shall be 5” round bi-metal type, stainless steel case, readable scale and gradations from 30°F to 240°F, external calibrator adjustment, back or bottom connection as appropriate. Provide brass extension neck sockets of appropriate length. Trerice Series No. B85200. Provide with minimum or maximum registering pointers.

2.3 THERMOMETER SOCKETS AND TEST WELLS

A. Brass construction with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series.

B. Test wells for stainless steel piping shall be same material as piping.

2.4 PRESSURE GAUGES

A. Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Taylor, Trerice, U.S. Gauge, Weiss, and Winters, equal to Trerice number listed

B. Pressure gauge shall be 4-1/2” die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge, Trerice Series No. 600.

C. Gauge accuracy shall meet ASME B40.1 Grade 1A (1% full scale).

D. Pressure gauges shall be calibrated for the following pressure ranges:

1. Domestic Water: 0 to 160 psi at 2 psi increments
2. Lab Air: 0 to 100 psi at 1 psi increments
3. Oxygen: 0 to 100 psi at 1 psi increments
4. Lab Vacuum: 30” Hg at 0.2” Hg increments

E. Pressure Snubbers:

1. 1/4” or 1/2” size, matching gauge size, 1000 psig WP. Brass for copper or carbon steel pipe, stainless steel for stainless steel pipe.

2.5 PRESSURE RELIEF VALVE

A. Manufacturers: Cash-Acme, Consolidated, Kunkle, Lonergan, and Watts

B. Bronze body, resilient seat/seal, ASME Section VIII, stainless steel spring

C. Refer to Schedules on drawings for performance requirements.

2.6 STRAINERS

A. Manufacturers: Conbraco, Hoffman, Keckley, Metraflex, Mueller, or Wheatley

B. Strainers shall be comparable to regulator or control valve specified. Strainers shall be "Y" type for liquid service to 400 lbs WOG at 210°F, with 40 mesh stainless steel screen. Body material shall be compatible with installed piping, stainless steel, or FDA approved, heat fused, epoxy coated interior.

2.7 BACKFLOW PREVENTER

A. Reduced Pressure Zone Backflow Preventers:

1. Manufacturers: Cla-Val, Febco, Apollo or Watts, equal to model listed
2. 3/4” through 2”: Bronze body, resilient check valve seats, shut-off valves, Y-pattern strainer with bronze body and stainless steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, equal to Watts number 919-S
3. 2-1/2” through 10”: Lead free body, stainless steel housing, EPDM elastomers, OS&Y isolation valves, drain air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, equal to Watts number 957

B. Double Check Valve Backflow Preventers:

1. Manufacturers: Cla-Val, Febco, Apollo or Watts, equal to model listed
2. 2-1/2” through 10”: Cast iron body, bronze trimmed check valves, OS&Y gate valves, bronze test cocks, certified in accordance with ASSE 1015 and AWWA C506, UL listed or FM approved. Cla-Val, Febco, Watts or approved equal, equal to Watts number 709-OSY.

C. Double Check with Vent (DCV) Backflow Preventers:

1. All bronze construction with stainless steel trim, union connections, 175 psi pressure rating, 250°F temperature rating, and conforming to ASSE Standard 1012. Watts No. 9D.

2.8 TRAP PRIMERS

A. Manufacturers: Precision Plumbing Products, Portland, OR.

B. Trap primer, TP-1: primer body shall be of machined brass with air inlet ports and backflow valve. Trap primer shall be activated by water pressure variation of 10 psi or greater to deliver metered amounts of water. Model PR-500

C. Distribution units shall be patented containers with 1 to 4 tube outlets. Two outlets maximum with model P-2, 3 to 4 outlets with model P-1.

D. Electronic trap primer manifold, TP-2; cabinet mounted; with 24 h timer, vacuum breaker, solenoid valve and hydraulic shock arrestor. Control wiring shall be 120 V single phase 3 wire connection for 120 V solenoid and 24 h timer. Box includes manual on/off switch and 2 amp fuse. Provide assembly without factory installed valve. Plumbing Contractor shall install a 3/4” ball valve as specified in Section 22 1118 - Water Distribution System. Cabinet shall be 14” x 16” x 3-1/2” deep, 16 ga box with 14” x 16” hinged prime coated door. MPB-500-115

E. Solenoid valve on inlet to be controlled by local timer. Timer to operate on 120 V power supply.

F. Precision Plumbing Products – Model MP-500-115V.

2.9 IN-LINE CHECK VALVES

A. Manufacturers: Circle Seal Control, DFT, Inc., Apollo Division - Conbraco Industries,

B. Bronze or bronze/stainless steel construction with spring loaded check (316 stainless steel spring) and straight through flow. Apollo Ball-Cone model 62-100 Series, or approved equal.

2.10 FLEXIBLE CONNECTIONS

A. Bronze, braided flexible hose or neoprene twinsphere connectors by Mason Industries with 150 psi WOG working pressure rating.

B. Alternate manufacturers are Redflex, Resistoflex and Flexonics.

2.11 AIR VENTS

A. Manual Air Vents: Bell and Gossett Model 4V, 125 psi pressure at 210°F temperature, or approved equal. Use 1/2" ball valve for main pipes.

2.12 FLASHINGS

A. Elastomer Membrane Roofing:

1. Pipe clamps, Fernco Series 1056 flex coupling with Series 300 stainless steel clamps.

B. Built-Up Roofing:

1. 4 lb/ft^2 sheet lead, to 18" beyond drain perimeter.
2. Preformed lead vent collar, 4 lb/ft^2 sheet lead, to 18" beyond vent perimeter; 18" minimum square base flange.
3. Nobleflex roof drain flashing of Chloraloy and 20 lb/ft^2 asphalt saturated roofing felt bonded together.

2.13 SAFINGS

A. 4 lb/ft^2 sheet lead, to 18" beyond edge of drain on all sides.

B. Chlorinated polyethylene (CPE) as manufactured by Noble Company under trade name Chloraloy 240.

C. Polyvinyl Chloride (PVC) shower pan line, 40 mil thickness, ASTM D4551.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide thermometers where indicated on drawings. Thermometers shall be easily read from floor or maintenance platforms. Calibrate thermometers to insure accuracy.

B. Install pressure gauges where indicated on drawings. Gauges shall be easily read from floor or maintenance platforms. Provide extensions as required to make gauges easily readable. Calibrate gauges to insure accuracy.

C. Install backflow preventers as indicated on drawings. Flush debris from strainers. Certified tester shall test reduced pressure zone backflow preventers to verify that functions are operational. Route vent line to adjacent hub drain.

D. Install strainers for equipment including pumps, meters, backflow preventers, reducers and regulators, and as shown on drawings.

E. **[Install trap primer units as recommended by manufacturer and as indicated for priming drain traps. Insure positive air gap to protect against backflow.] [Install in-line trap sealer as recommended by manufacturer.]**

F. Install in-line check valves where specified or as indicated on drawings.

G. Install flexible connections for base mounted pumps and other vibrating equipment.

H. Install air vents at high points in water systems where air may collect.

I. Safing:

1. Install safing for floor drains. Extend safing to 18” from edge of drain. Safing shall be clamped to floor drain body and pitched to drain to weep holes. Floor drains installed in unexcavated areas do not require safing.
2. Where core drilled floor drain installation into existing floor slab has been approved by A/E, drain strainer inlet shall be grouted in place with non-shrink epoxy concrete approved by Structural Engineer. Refer to detail Section 22 0690 - Plumbing Details.
3. Install safings for showers. Concrete floor shall be smooth and free of dirt. Seal joints per manufacturer's recommendations and turn up sides minimum of 6” above curb or maximum water level. Safing shall clamp into drip pan of floor drain and be secured by flashing clamp to assure drainage into weep holes of drain body. Inside vertical corners of showers shall have 12” strips 6 ft above floor, extend 6” in each direction and bottom to overlap pan 3”.
4. Membrane roofing material, preformed elastomer pipe pots, and flashing seams are provided by Roofing Contractor for pipe penetrations and drain flashing. Plumbing Contractor shall provide drain flashing clamps and stainless steel strap clamps for piping penetrations. Coordinate with General Contractor to facilitate sealing drain flashing and pipe penetrations.

J. Flashing:

1. Coordinate flashings on roof closely with Roofing Contractor. Install flashings as required to insure proper vapor barrier and as directed by Architect.
2. Install flashing for roof drains and overflow drains. Flashing shall extend minimum of 18” beyond edge of drain and shall be clamped into drain body.
3. Use premolded flashing assembly for roof penetration of medical air intake piping. Install 1” of insulation between flashing and outside of pipe.
4. Use premolded flashing assembly with hood for roof penetrations of medical vacuum exhaust piping. Set bottom of hood at 24” above finished roof.
5. Roof penetrations for corrosive or acid vent systems shall be preformed EPDM vent pot with flex coupling pipe clamp collar.

3.2 TESTING

A. Safings shall be subject to standing water test to detect leaks and proper drainage to weep holes of floor drain.

END OF SECTION 222144

SECTION 223100 - WATER CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section lists equipment to be used to condition domestic water systems.

1.2 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 22 2114 - Plumbing Specialties

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Marlo, Culligan, Hellenbrand, U.S. Filter

2.2 SOFTENER

A. Description: duplex, parallel, water softener shall include three fiberglass vessels with internal distributors, piping, fully automatic brass multi-port control valves, alternating controller, pressure gauges, sample valves, resin, gravel, outlet "Y" strainer, structural base, dry-brine maker and brine eductor. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Conditions:

1. Design flow: Refer to equipment schedule
2. Pressure: 30-80 psig
3. Temperature: 50°F to 80°F

C. Design Criteria:

1. Volumetric Flow Rate: less than 15 gpm/ft^3 at design flow rate
2. Backwash Flow Rate: greater than 1.2 gpm/ft^3
3. Maximum Hardness Leakage: 5 ppm (less than)
4. Normal Hardness Leakage: 0 ppm

D. Resin:

1. Type: Gel - strong acid cation

2. Ionic Form Sodium
3. Regenerant Chemical: NaCl saturated
4. Regenerant Quantity: 15 gpm/ft^3 maximum
5. Method of Chemical Introduction: Eductor
6. Capacity/ft^3 (est.): 30,000 grains (as $CaCO_3$) at max salt dosage

E. Mechanical:

1. Softener vessel:
   a. Material: Fiberglass
   b. Pressure Rating: 100 psig/150 psig
   c. Temperature Rating: 120°F
   d. Piping Connections: soldered
   e. Warranty: two years against interior, exterior and lining defects.
   f. Upper distributor: Single point baffle type, schedule 40 galvanized
   g. Lower distributor: hub and radial arm type, PVC or ABS

2. Strainer: Bronze or PVC body with 20 mesh screen

F. Brine tank:

1. Quantity: one
2. Material: Polyethylene
3. Salt Dose: 6-15 lb/ft^3

G. Electrical

1. Controls: Motor-driven control valve shall stage each softener through regeneration steps. Regeneration shall be initiated by a signal from alternator controller. Regeneration frequency shall be based on throughput volume, totalized at common effluent of both softeners.
2. 120 vac, 1 ph, 60 Hz power supply

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water conditioning equipment level in location as shown on drawings. Support pipe to and from equipment from building structure; do not support piping from equipment.

B. Follow installation instructions of equipment manufacturer. Installation instructions shall always be at site.

C. Provide start up service by manufacturer or authorized representative.

D. Fill salt storage/brine tank after successful test results.

3.2 TEST

A. Operate equipment through regeneration cycle. Verify proper cycle time and brine injection.

B. After satisfactory performance of sequence of operation, take water samples of raw and conditioned water and send to lab to verify performance of the equipment.

3.3 BALANCING

A. Adjust equipment to work with minimum dosage of brine.

END OF SECTION 223100

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SECTION 223314 - WATER HEATING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions of Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Water heating equipment shall conform to State and Local Codes, meet national standards, and be certified by respective organization and bear its stamp.

1.3 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.2 ATMOSPHERIC GAS FIRED TANK TYPE WATER HEATER

A. Manufacturers: A.O. Smith, Bock, Bradford White, Lochinvar, Rheem, Ruud, State

B. Water heater shall be high efficiency atmospheric gas fired water heater. Water heater design shall bear “CSA Design Certified” mark, have 5 yr tank warranty and have 1 yr parts warranty.

C. Burner shall be cast iron or stainless steel with thermostat adjustment of 90°F to 180°F. Controls shall be arranged for emergency shut off in event of pilot failure.

D. Tank shall be glass lined steel ASME rated for 150 psig. Tank shall have removable magnesium anode rod, pressure and temperature relief valve, drain valve, boiler-type hand-hole cleanout, draft hood, polyurethane insulation, painted steel jacket, inlet and outlet thermometers, and gas pressure regulator set for operation at 14” WC natural gas.

E. Refer to Water Heater Schedule for water heater capacity required.

2.3 THERMAL EXPANSION TANK

A. Manufacturers: Amtrol, Goulds, Wessels

B. Expansion tank shall be precharged, diaphragm-type tank designed for hot water systems. Tank shall be ASME rated for 125 psig and come with replaceable rubber bladder, air charge fitting, steel base ring stand (floor mounted tanks only), factory primed and enamel painted exterior, and ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

C. Refer to Tank Schedule for expansion tank capacity requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water heaters as recommended by manufacturer. Provide final connections as required. Coordinate water heater location with other Contractors.

B. .Initial start up and balancing service shall be provided by representative of manufacturer.

END OF SECTION 223314

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section lists plumbing fixtures and accessories including method of installation.

1.2 RELATED WORK

A. Section 22 1118 - Water Distribution System

B. Section 22 1314 - Sanitary Waste and Storm Drainage Systems

C. Section 22 1600 - Natural Gas Piping

D. Section 22 6114 - Laboratory Compressed Air System

E. Section 22 6214 - Laboratory Vacuum Piping System

F. Section 22 6653 - Corrosion Resistant Waste and Vent System

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.

B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

B. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.

C. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.

D. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self-rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and coved corners, with faucet holes punched to match specified faucet fitting.

E. Precast receptors and shower basins shall be molded "stone" inert base and plasticizer. Receptor and basin colors shall be standard colors unless otherwise noted. Assembly of drain to waste piping shall be made from floor level on which basin or receptor is installed.

F. Insulation for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

2.2 MANUFACTURERS

A. Plumbing fixtures shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.

B. Water closets, urinals, and lavatories: American Standard (website), Kohler (website), or Zurn (website) equal to number listed

C. Water Closet Seats: Bemis (website), Beneke, Centoco (website), Olsonite (website) or Zurn (website) equal to number listed

D. Waterless Urinals: Falcon (website), Kohler (website), or Sloan, equal to number listed

E. Flush Valves: Delaney, Sloan (website) or Zurn (website) equal to number listed

F. Stainless Steel Sinks: Advance Tabco (website), Elkay (website) or Just (website) equal to number listed

G. Electric Water Coolers: Elkay (website), Halsey-Taylor (website), Haws (website), Oasis (website), or Sunroc (website) equal to model listed

H. Service Sinks: American Standard (website), Eljer (website), or Kohler (website) equal to number listed

I. Mop Basins (Janitor Sinks): Fiat (website), Mustee (website), Stern-Williams (website), or Zurn (website) equal to number listed

J. Emergency Eyewashes and Showers: Acorn (website), Bradley (website), Encon (website), Guardian (website), Haws (website), or Speakman (website), equal to number listed

K. Manual Faucets: Chicago Faucet (website), T and S Brass (website), or Zurn (website) equal to number listed

L. Manual Faucets: Chicago Faucet (website), Delta HDF (website), Kohler (website) or Moen Commercial (website), equal to number listed

M. Sensor Activated Faucets: Bradley (website), Chicago Faucet (website), Kohler (website), Sloan (website), TOTO (website) or Zurn (website) equal to model listed

N. Fixture Traps: Engineered Brass Company (website), Kohler (website), McGuire (website), or Zurn (website) equal to number listed

O. Insulated Traps and Supplies: McGuire (website), ProFlo, or True-Bro (website) equal to model listed

P. Supplies and Stops: Chicago Faucet (website), Kohler (website), McGuire (website) or Zurn equal to number listed

Q. Supplies and Stops: Brasscraft (website), Engineered Brass Company (website), Kohler (website), LSP Aqua-Flo (website) or McGuire (website) equal to number listed

R. Shower Valves and Mixing Valves: Leonard (website), Powers (website), or Symmons (website) equal to number listed

S. Shower Valves and Mixing Valves: Chicago Faucet (website), Grohe, Kohler (website), or Moen Commercial (website) equal to number listed

T. Multiple Showers: Acorn (website), Bradley (website), or Willoughby (website) equal to number listed

2.3 CARRIERS AND SUPPORTS

A. Carrier manufacturers shall be Josam (website), J.R. Smith (website), Wade (website), or Zurn (website), as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.

2.4 REFER TO SCHEDULE ON DRAWINGS FOR DETAILED FIXTURE SELECTION CRITERIA

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with silicone sealant, same color as fixture.

B. Support fixtures with proper carrier for each use. Insure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3” minimum into concrete slab.

C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.

D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.

E. Install barrier free fixtures in compliance with local code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27” above finished floor to avoid contact by wheelchair users.

F. Return fixture waste and supply piping into wall as high as practical under fixture. Provide accessible shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.

G. Coordinate with Electrical Contractor for electronic sensor wiring necessary to install "sensor" operated fixtures. Provide "shockstops" at supplies to solenoid activated fixtures.

H. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.

I. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.

J. Provide unions at water connections to drinking fountains and electric water coolers.

3.2 LABORATORY BENCH AND CUP SINKS

A. Set fixture, faucet, eyewash, drain and tailpiece.

B. Make final waste, vent and water connections to fixture.

C. Purified water outlets do not require fixture stops.

3.3 LABORATORY CASEWORK OUTLETS

A. Set fixtures in predrilled casework.

B. Make final connection of fixture to service piping.

3.4 FUME HOODS

A. Set cup sink, faucet, drain and tailpiece.

B. Make final connections to service piping or pre-piped hood. Vent piping for cup sink will not be pre-piped.

3.5 PROTECTION

A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.6 CLEANING

A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer and remove stains and marks from surrounding walls and countertops.

END OF SECTION 224000

SECTION 224014 - EQUIPMENT BY OTHERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Items specified herein shall be provided by Plumbing Contractor to make equipment provided by others and Owner functional.

1.2 RELATED WORK

A. Section 22 1118 - Water Distribution System

B. Section 22 1314 - Sanitary Waste and Vent System

C. Section 22 1600 - Natural Gas Piping

D. Section 22 2114 - Plumbing Specialties

E. Section 22 6653 - Corrosion Resistant Waste and Vent System

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions of Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.

B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.2 OWNER FURNISHED EQUIPMENT

A. Where utility services are required for equipment connection, provide the following:
   1. Gas utilities services shall terminate with quick connect outlet; Hanson Coupling #3-HK.
   2. Pressure relief device between isolation valve and quick connect on pressurized gas services; Ross L-O-X Series 15.

2.3 ICE MACHINE (EQ-IM-X)

A. Provide isolation valve on domestic water supply. Refer to Section 22 1118 for specific information.

B. Provide water hammer arrestor on domestic water supply. Refer to Section 22 1118 for specific information.

C. Provide dual check backflow preventer on domestic water supply. Refer to Section 22 2114 for specific information.

D. Provide water filter on water supply. Filter shall have (2) 0.5 micron filter cartridges piped in parallel, inlet and outlet lead free isolation valves, flush kit, and inlet and outlet pressure gauges. Filter shall be Watts QTCBMX-2L-.5M or approved equal.

E. Provide indirect waste pipe from ice machine to local drain. Refer to Section 22 1314 for specific information**.**

2.4 GLASS WARE WASHER (EQ-GW-X)

A. Provide isolation valves on domestic water supplies. Refer to Section 22 1118 for specific information.

B. Provide water hammer arrestors on domestic water supplies. Refer to Section 22 1118 for specific information.

C. Provide dual check backflow preventer on domestic water supply. Refer to Section 22 2114 for specific information.

2.5 AUTOCLAVE (EQ-AU-X)

A. Provide isolation valves on domestic water supply. Refer to Section 22 1118 for specific information.

B. Provide water hammer arrestor on domestic water supply. Refer to Section 22 1118 for specific information.

C. Provide reduced pressure backflow preventer on domestic water supply. Refer to Section 22 2114 for specific information.

D. Provide indirect waste pipe from autoclave to local drain. Refer to Section [22 1314][22 6714.16] for specific information.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plumbing Contractor shall install items specified herein as recommended by respective manufacturers. Final connections of waste, water, air, gas, etc., shall be installed by Plumbing Contractor as directed by equipment manufacturer. Incidental items, such as, adapters and unions required to make final connection shall be provided by Plumbing Contractor.

B. Coordinate rough-in sizes and elevations with equipment supplier before proceeding with work.

END OF SECTION 224014

SECTION 226114 - LABORATORY COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers piping and equipment required to provide laboratory grade compressed air at **-40**ºF dew point at 100 psi system pressure as shown on plans and details.

1.2 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0529 - Piping and Equipment Supporting Devices

C. Section 22 4014 - Equipment by Others

D. Section 23 0550 - Vibration Isolation

E. Section 26 2913 - Enclosed Controllers

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. Items listed as “Cleaned for Oxygen Service” shall comply with requirements of CGA Standard G-4.1, Cleaning Equipment for Oxygen Service.

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

1.5 PRODUCT DELIVERY

A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.

B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 PIPE AND FITTINGS

A. Above Ground

1. Copper
   a. Pipe: Copper tube, Type L, hard temper, ASTM B88
   b. Fittings:
      1). Wrought copper or bronze, solder joint, pressure rated, ANSI B16.22

2). Cast copper alloy, solder joint, pressure rated, ANSI B16.18

c. Joints (3" and smaller): Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32; flux, ASTM B813

d. Joints (4" and Larger): Brazed, BcuP-5 type, AWS A5.8, 1250ºF melting point minimum

2.3 UNIONS

A. Copper 3" and smaller:

1. Wrought copper union, Nibco 633-W

B. Copper 4" and larger:

1. Cast red brass flanges, alloy 844, ASTM B584, Class 150, ANSI B16.24 with neoprene gasket

2.4 VALVES

A. Ball Valves:

1. Acceptable manufacturers: Apollo, Nibco, Watts
2. 3" and Smaller:
   a. Full port, 2-piece, bronze body, chrome plated bronze ball, teflon seats, blowout-proof stem, and threaded or soldered joint, Watts FBV or FBVS
   b. Full port, 3-piece, bronze body, stainless steel ball, PTFE seats, stainless steel trim, blow-out proof stem, 6" tube extension, oxygen cleaned and bagged, quarter turn handle, 600 psi CWP; Nibco CS-595-YX-66-EC Series through 2"
   c. Full port, 3-piece, bronze body, stainless steel ball, PTFE seats, stainless steel trim, blow-out proof stem, 600 psi CWP; Nibco T- or S-595-Y-66 Series through 3"

3. 2" and Smaller for Lock-out/Tag-out
   a. Conventional port, 2-piece, bronze body, stainless steel ball, Teflon seats and seals, stainless steel trim, blow-out proof stem, pad locking handle in closed position, automatic venting of downstream pressure in closed position, cleaned and bagged for oxygen service, 600 psi CWP; Apollo 75-140-41-57

B. CHECK VALVES

1. Acceptable manufacturers: Apollo, Nibco, Watts
2. 2" and smaller:
   a. Spring loaded, bronze or bronze/stainless steel body, 316 stainless steel spring, straight through flow, shipped bagged and oxygen clean. Apollo Ball-Cone Model 62-100-57.

2.5 PRESSURE REGULATORS

A. Manufacturers: Cashco, Fisher, Jordan or approved equal

B. Bronze body and spring case, direct acting valve, manual adjustment screw with top nut, stainless steel trim, resilient valve seat, cleaned for oxygen service. Valve shall be capable of XXX cfm with outlet pressure of XXX psig with inlet pressure of XXX psig.

2.6 AUTOMATIC DRAIN DEVICE

A. Acceptable manufacturers: Jorc or approved equal

B. Automatic condensate removal device with zero air loss during condensate discharge. Drain device shall have Viton seals and shall have 120 V power connection.

C. Basis of design is Jorc “Smart Guard Ultra” capable of up to 3600 scfm at up to 230 psig at 34-112°F.

2.7 OIL-LESS ROTARY SCROLL AIR COMPRESSOR (LAC-1)

A. Manufacturers: Powerx, Atlas Copco, Ingersoll-Rand, Kaeser, Kobelco, Quincy

B. Air compressor package shall be multiple, oil less rotary scroll units piped in parallel. Compressors shall be base mounted on frames with forklift slots. Compressors shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air compressor enclosure shall include vibration isolation meeting requirements of Section 23 0550 – Vibration Isolation. If enclosure cannot meet requirements of Section 23 0550, enclosure shall be provided with external isolators. Vibration isolators shall not be installed in series.

D. Compressors shall operate in lead/lag/alternate configuration. Panel for compressor control shall be included with package.

E. Each compressor shall be provided with following components:

1. 10 micron inlet filter
2. Air intake silencer
3. Compressor unloading valve
4. Discharge air check valve
5. Manual compressor isolation valve
6. Air cooled aftercooler
7. Discharge air/water separator
8. 460 V, 3 Ph motor meeting efficiencies listed in 20 0513
9. Capacity of 50 cfm at 145 psig
10. Compressor control panel shall be NEMA 4 rated enclosure with gauges, controls and indicators to monitor the following operations:
    a. One main fused disconnect.
    b. Magnetic across-the-line starters with thermal overload protection
    c. Control functionality to start and stop multiple compressors in lead-lag-alternate sequence. Each compressor shall be capable of being master control machine.
    d. 120 V control transformer
    e. Intercooler pressure
    f. Compressor discharge pressure gauge
    g. Air
    h. Oil pressure
    i. Low oil pressure alarm
    j. First stage outlet air temperature
    k. High first stage outlet air temperature alarm
    l. High temperature shut-down switch
    m. Power indicator "ON" light
    n. Run time hour indicator
    o. Hand-off-auto switch
    p. Motor overload alarm

q. Extra set of dry contacts for general alarm signal to Building Automation System

F. See Schedule on drawinfor Basis of Design.

2.8 AIR RECEIVER (PART OF LAC-1 SKID)

A. Manufacturers: Powerx, Adamson, Brunner or approved equal

B. Air receiver shall be an ASME rated **vertical** vessel. Receiver shall have the following components:

1. 120 gal capacity
2. 200 psig rated maximum working pressure
3. Ring base with access hand holes
4. Inlet and outlet pressure gauges
5. Safety relief valve with soft seat
6. Automatic drain device
7. Outlet pressure regulating valve
8. Epoxy coated interior

2.9 DESICCANT AIR DRYER (PART OF LAC-1 SKID)

A. Manufacturers: Powerx, Arrow by McIntire, Deltech, Hankinson, Pneumatic Products

B. Air dryers shall be twin tower, heatless regenerative units . Air dryers shall be factory wired, piped and tested prior to delivery to jobsite.

C. Air dryer shall be provided with following components:

1. Duplex inlet coalescing filters with automatic drain device
2. Duplex outlet particulate filters
3. 150 psig rated working pressure
4. Automatic purge cycling based on dewpoint demand
5. Purge air silencers
6. Desiccant chamber pressure relief valves
7. Capacity of XXX scfm at -40ºF dew point discharge air
8. 120 V, 1 Ph power connection
9. NEMA 4 control panel with following features
   a. Desiccant chamber pressure gauges
   b. Purge air flow indicator
   c. Locally mounted dewpoint indicator
   d. High humidity alarm
   e. Desiccant chamber switch failure alarm
   f. Extra set of dry contacts for alarm monitoring to Building Automation System

D. See Schedule on drawings for Basis of Design.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install compressed air piping as shown on drawings and details.

B. Provide low point drain valve at bottom of risers. Pipe mains shall not be trapped between connection at riser and last branch take-off. Branch take-offs to rooms or individual spaces shall be from top of main.

C. Provide flexible connections at compressor inlet and outlet connection points as shown on details.

D. Cut copper tube square and ream before assembly. Keep piping capped during construction to prevent intrusion of construction debris.

E. Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or workbenches using appropriate hangers, anchors, or Unistrut.

F. Install unions on equipment side of shutoff valves for items such as: air dryers, receiver, compressors, filters, and similar equipment requiring periodic replacement or maintenance.

G. Install vented valve for lock-out/tag-out at connection to equipment. Vented valve shall meet OSHA requirements for disabling power source and bleeding downstream energy.

H. Install temporary plugs and caps on openings during construction phase.

3.2 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

C. Brazed Copper Joints:

1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point at approximately 1250ºF. Solder impurities shall not exceed 0.15%.
2. Tubing shall be delivered to site with original mill caps in place.
3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
4. Joints shall be cleaned and polished before brazing.
5. Flux of any type shall not be used.
6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.

3.3 AIR COMPRESSORS

A. Provide wiring necessary for controls and automation systems interface.

B. Air compressor package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer's recommendations. Consult manufacturer-furnished piping diagrams for interconnecting piping of system components.

C. Installation shall be inspected and approved by manufacturer's field representative. Equipment start-up shall be performed by manufacturer's representative in presence of Owner's representative.

D. Air compressors shall be configured to operate in lead/lag/alternate sequence by pressure switch in receiver set to operate between 100 and 115 psig**.**

3.4 TESTING

A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Air piping shall be tested at 150 psig for 2 h prior to connection of laboratory fixtures. Soap test each joint to detect leaks during test period. No loss of pressure allowed during test period. Defective joints shall be cut out and replaced. Air piping shall be re-tested at 100 psig for 8 h after final connection of laboratory fixtures.

C. Air compressor equipment shall be delivered pre-assembled and tested by equipment manufacturer.

D. Verify proper signal transmission for each condition specified to Building Automation Controller.

3.5 CLEANING

A. All pipe, fittings and valves will be cleaned by manufacturer. On- or off-site cleaning of any components by Contractor is not allowed. Any components, which have become contaminated, will not be used on any clean systems. They may be used in laboratory vacuum or any water system using copper pipe or fittings.

B. Before system is placed into use, flush piping with product air to remove foreign particles.

3.6 WARRANTY

A. Manufacturer shall warrant air compressor package and components complete, for period of 2 yrs from date of start-up.

END OF SECTION 226114

SECTION 226214 - LABORATORY VACUUM PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers piping and equipment required to provide laboratory vacuum at 19" Hg at pump intlet and vacuum pump equipment as shown on drawings for general laboratory vacuum outlets in **[XXX]**.

1.2 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0529 - Piping and Equipment Supporting Devices

C. Section 20 0549 - Seismic Anchorage and Restraints

D. Section 22 2114 - Plumbing Specialties

E. Section 22 4014 - Equipment by Others

F. Section 23 0550 - Vibration Isolation

G. Section 26 2913 - Enclosed Controllers

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SUBMITTALS

A. Shop Drawings on items specified herein

1.5 PRODUCT DELIVERY

A. Deliver pipe and equipment properly packaged to protect against shipping and handling damage.

B. Installed pipe shall be sealed during construction to prevent construction debris from entering piping system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials as specified shall be new unless otherwise noted.

2.2 PIPE AND FITTINGS

A. Above Ground

1. Copper
   a. Pipe: Copper tube, Type L, hard temper, ASTM Specification B88

b. Fittings:
   1). Cast copper alloy, solder joint, pressure rated, ANSI B16.18
   2). Wrought copper or bronze, solder joint, pressure rated, ANSI B16.22
c. Joints: Lead free (<0.2%) solder, Bridgit or Silvabrite, ASTM B32; flux, ASTM B813

2.3 FLANGES

A. Copper:

1. Cast red brass, Alloy 844, ASTM B584, Class 150 (150 psig), Standard bolt pattern, ANSI Standard B16.24 with neoprene gasket

2.4 VALVES

A. Copper Piping Systems:

1. Manufacturers: The following list of valve manufacturers is acceptable unless otherwise noted subject to providing valves equal to items specified: Nibco, Apollo and Watts
2. Size 4” and Smaller:
   a. Ball Valves: Full port, 3-piece bronze body, quarter turn, stainless steel ball and stem, Teflon seats, blowout-proof stem, 600 psi CWP rated, screwed or soldered joint. Apollo 82-140 Series or Apollo 92-240 Series

2.5 DIELECTRIC FITTINGS

A. Dielectric Flanges (3” and Larger)

1. Acceptable Manufacturers: Epco Sales Inc., Lochinvar, Watts, Wilkins
2. Iron female pipe thread to copper solder joint end connections, non-asbestos gaskets, pressure rating of not less than 175 psig at 180ºF.

2.6 ROTARY VANE VACUUM PUMP SYSTEM (LV-XXX)

A. Acceptable Manufacturers: Powerex, Beacon Medaes, Busch, Rietchle-Thomas, Becker, Air-Tech

B. System Description:

1. Vacuum pump package will be skid mounted and will include receiver tank, vacuum pumps, motors, all electrical components, valves, and piping.
2. Vacuum pumps will be duplex configuration and a single ASME Rated vertical vacuum receiver. Each vacuum pump will be independently mounted having independent flexible connectors on inlet and outlet of each pump.
3. Pump package will have single points of connection for vacuum, vacuum exhaust, and electrical. Electrical feed will be 480 V, 3 Ph service. Transformers for devices requiring additional voltage supply will be provided with package.
4. Vacuum pumps will be air cooled, rotary vane, single stage. Pumps will be direct drive, positive displacement, non-pulsating type. Each pump will have the following:
   a. Totally enclosed, fan cooled (TEFC), continuous duty motor. Suction line 5 micron filter, isolation valve, and liquid filled vacuum gauges with isolation valves.
   b. Integral piping and fittings for all components. All pump connections will have flexible connectors.
   c. Each pump suction will be manifolded to one 150 lb (150 psig) flanged connection.

d. Automatic purge system to flush any gases from pump and prevent condensation as pump cools. Purge system will include isolation valve and actuator, solenoid bleed valve, and controls to operate a 15 minute shutdown purge.
e. Pump drain manifold, piped from each pump oil drain valve.
f. Materials of Construction
   1). Vacuum pump: Cast iron casing, non-metallic, non-asbestos vanes, oil lubricated bearings, single mechanical seals
   2). Piping: Schedule 40 carbon steel per ASTM A-53 Grade B, threaded 2” and smaller, flanged or welded for piping larger than 2”
   3). Base plate: Carbon Steel

C. Pump lubrication will be by an integral, fully recirculating oil supply including oil filter.

D. Vacuum system will be controlled by skid-mounted packaged control system. Programming of vacuum system will be by system vendor. Local duplex Programmable Logic Controller (PLC) will include:

1. UL Listed NEMA 12 Enclosure with across line magnetic starters, circuit breakers, one main fused disconnect, hour meters for each pump
2. Lead-lag pump alternator to control pumps so each pump receives equal run time and rotates through lead pump position, and capability for simultaneous pump operation.
3. Hand-off-auto switch for each pump
4. Manual purge/stop-auto switches for each pump
5. One hundred fifteen volt control transformer with fused primary and secondary
6. Differential type vacuum control switches, field adjustable pump run meters, pump run and alarm lights and audible alarm with silence button, and vacuum gauges, and water temperature read-out devices for each pump, and terminal strip for external conditions.
7. All contacts, vacuum switches, relays, and other necessary accessories. Include extra dry contacts to signal Utility Monitoring System PLC of vacuum switch trips and equipment failures.
8. Frequent start protection with automatic pump shutdown.

E. Vacuum receiver will be ASME rated for 30” Hg vacuum,carbon steel with epoxy phenolic interior lining. Tank shall be fitted with inlet and outlet flange connections, level gauge, vacuum gauge with isolating valve, sight gauge glass, and tank drain valve. Tank drain valve shall have discharge pipe routed to skid perimeter.

F. Vacuum pump skid shall include vibration isolation meeting requirements of Section 23 0550 – Vibration Isolation. If skid can not meet requirements listed in Section 23 0550, skid shall be manufactured without vibration isolators and external isolation shall be provided. Vibration isolators shall not be installed in series.

G. System Capacity

1. Refer to schedule on drawings for vacuum pump operating capacities and criteria.

2.7 WARRANTY

A. Complete system shall be warranted by manufacturer for 2 yrs from date of startup. Pumps shall be warranted by manufacturer for **[XXX]** yrs from startup. This warranty will include parts and labor on items returned to factory for repair and/or replacement. Labor costs associated with on-site warranty repairs shall also be covered by manufacturer and Contractor for minimum 1 yr from date of startup.

B. Complete vacuum pump system shall be completely factory assembled and factory pre-tested prior to shipment to job site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install vacuum piping as shown on drawings and details.

B. Provide low point drain valve at bottom of risers. Pipe mains shall not be trapped between connection at riser and last branch take-off. Branch take-offs to rooms or individual spaces shall be from top of main.

C. Provide line size cleanout plug at end of corridor distribution mains for flushing out piping.

D. Base-mounted pumps shall be anchored to structure in accordance with seismic restraint requirements. Refer to Section 20 0549 - Seismic Anchorage and Restraints.

E. Provide vibration isolators for base or skid-mounted pumps.

F. Provide wiring necessary for float control switches, safety switches, solenoid valves, and controls interface required. Coordinate power requirements with Electrical Contractor.

G. Flexible connections shall be provided as shown on drawings.

H. Installation shall be inspected and approved by manufacturer's field representative. Equipment start-up shall be by manufacturer's representative in presence of Owner's representative.

3.2 PIPING SYSTEMS

A. Piping for Laboratory Vacuum system shall be copper.

B. Piping for Laboratory Vacuum Exhaust shall be **CPVC**.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Soldered Copper Joints:

1. Use non-acidic and lead free flux on cleaned pipe and fittings for soldered joints.
2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

3.4 VACUUM PUMPS

A. Provide wiring necessary for controls and automation system interface.

B. Vacuum pump package with components and accessories shall be furnished by one manufacturer. Install components according to manufacturer's recommendations. Consult manufacturer furnished piping diagrams for interconnecting piping of system components.

C. Installation shall be inspected and approved by manufacturer's field representative. Equipment startup shall be performed by manufacturer's representative in presence of Owner's representative.

D. Vacuum pumps shall be configured to operate in lead/lag/alternate sequence by pressure switch in receiver set to operate between 25" and 29" of mercury vacuum.

3.5 CLEANING

A. Before system is in use, flush piping with dry compressed air to remove foreign particles.

3.6 TESTING

A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Vacuum piping shall be tested at 200 psi for 2 h prior to connection of laboratory fixtures. Soap test each joint to detect leaks during test period. No loss of pressure allowed during test period. Vacuum piping shall be re-tested at 100 psi for 8 h after final connection of laboratory fixtures.

C. Test plastic vacuum exhaust piping with air, maintaining pressure of 15 psi for 2 h with no loss in pressure allowed. Inspect all joints in system. Do not conceal any piping until satisfactorily tested. Defective joints shall be repaired and retested. Mercury column gauge shall be used to register air pressure.

D. Vacuum pump equipment shall be delivered un-assembled and pre-tested by equipment manufacturer.

E. Verify proper signal transmission for each condition specified to Building Automation Controller.

END OF SECTION 226214

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SECTION 226314 - NITROGEN, CARBON DIOXIDE AND SPECIAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies nitrogen, carbon dioxide and special gases, piping and related accessories. Special gas piping system shall include distribution of gases from bulk liquid storage tanks, from gas cylinder central manifolds, and from localized point-of-use gas cylinder manifolds to terminal devices at individual points of use throughout the building.

B. Special gases shall include but not be limited to Helium, Hydrogen, Oxygen, Carbon Dioxide and Argon.

1.2 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 20 0553 - Mechanical Systems Identification

C. Section 22 6214 - Laboratory Vacuum Piping System

D. Section 22 6114 - Laboratory Compressed Air System

1.3 REFERENCE

A. Items listed as “Cleaned for Oxygen Service” shall comply with requirements of CGA Standard G-4.1, Cleaning Equipment for Oxygen Service.

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 PIPE

A. Above Ground:

1. Copper
   a. Pipe:
      1). Copper tube, Type L, hard temper, cleaned and capped, ASTM B280, and marked "ACR" or similar in accordance with ASTM
      2). Copper tube, Type L, hard temper, cleaned and capped, ASTM B819, marked “MED” or similar in accordance with ASTM

b. Fittings:
   1). Cast copper alloy, solder joint, pressure rated, cleaned and bagged for oxygen service, ANSI B16.18
   2). Wrought copper or bronze solder joint, pressure rated, cleaned and bagged for oxygen service, ANSI B16.22

c. Joints: Brazed, silver solder, BCuP-3 or BCuP-5 type, AWS 5.8, 1250ºF melting point minimum

2. Stainless Steel

a. Pipe: Stainless steel tubing, Type 316, ASTM A269, hardness not to exceed Rb80, fully annealed, seamless tubing, free of scratches, burrs and surface defects, suitable for bending and flaring for sizes 1/16" through 2", cleaned for oxygen service. Minimum pipe wall thickness shall meet the following requirements:

Pipe Size (")	**Minimum Wall Thickness (")**	**Maximum Working Pressure (**psi**)**
1/8	0.028	8500
1/4	0.028	4000
3/8	0.049	4800
1/2	0.065	5100
5/8	0.065	4000
3/4	0.065	3300
1	0.083	3100
1-1/4	0.120	3600
1-1/2	0.134	3400
2	0.188	3600

b. Fittings and Joints: Type 316 stainless steel, double ferrule, compression by male, or compression by female tubing fittings, cleaned and bagged for oxygen service.
   1). Acceptable manufacturers: Parker, Swagelok, SSP Instrumentation, Tylok

2.2 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers: Saint-Gobain or approved equal

B. Teflon smooth inner tube with outer 304 stainless steel braid, stainless steel crimped on end connections, -100ºF to 450ºF continuous temperature rating, 500 psig maximum working pressure, cleaned and capped for oxygen service.

C. Saint-Gobain TS series with XXX ends.

2.3 UNIONS

A. Copper 3" and smaller:

1. Wrought copper union, cleaned and bagged for oxygen service, Nibco Fig. 633-W. Mueller brass equal.

B. Copper 4" and larger:

1. Cast red brass flanges; alloy 844 ASTM B584, Class 150, ANSI B16.24 with neoprene gasket, cleaned and bagged for oxygen service

C. Stainless Steel 2” and smaller:

1. Swagelok Type 316 stainless steel, double ferrule tubing coupling, cleaned and bagged for oxygen service

2.4 VALVES

A. Copper:

1. Ball Valve
   a. Size 2” and Smaller:
      1). Acceptable manufacturers: Apollo, Nibco, Watts
      2). Full port, 3-piece, stainless steel ball, PTFE seats, stainless steel trim, blow-out proof stem, 6” tube extension, oxygen clean and bagged, quarter turn handle, 600 psi CWP rated,Nibco S-595-YX-66 Series
   b. Size 3” and Larger:
      1). Acceptable manufacturers: Jamesbury, Nibco, Watts, Worcester
      2). Full port, stainless steel body and trim, quarter turn lever handle, 150 lb class flanged ends, Teflon seats and seals, end entry, ductile iron handle wrench, oxygen cleaned and bagged, 150 psi CWP. Nibco F-510 Series.

2. Butterfly Valve
   a. Size 3” and Larger:
      1). Acceptable manufacturers: Apollo, Kennedy, Nibco, Watts
      2). Ductile iron body, lug design, aluminum bronze or stainless steel disc, stainless steel stem, molded-in EPDM liner, Class 150 ANSI B16.1 flange ends, suitable for dead end shut-off to 175 psi with no downstream flange attached; oxygen cleaned and bagged, memory stop with locking device, lever actuator through 4”, gear operator 5” and larger.

B. Stainless Steel:

1. Ball Valve
   a. Size 2” and Smaller:
   b. Acceptable manufacturers: Parker, SSP Instrumentation, Swagelok, Tylok
      1). Full port, 3-piece, stainless steel body, quarter turn level handle, stainless steel ball and blow-out proof stem, stainless steel trim, Swagelok or NPT ends, reinforced Teflon seats and seals, oxygen cleaned and bagged, 600 psi CWP rated. Swagelok Series 60.

2.5 PRESSURE REDUCING VALVES

A. Acceptable Manufacturer: AGA/Linde, Norgren, Tescom

B. Regulator shall be made from high purity brass or stainless steel barstock and have Hastelloy diaphragms. Regulator shall be cleaned and bagged for oxygen service. Regulator shall have 0-80 psig outlet pressure range and be provided with outlet pressure gauge. Gauge shall be selected such that operating pressure is in center of gauge pressure range. Inlet and outlet connections shall be 1/4” female NPT minimum.

C. Refer to schedule on drawings for flow rate and pressure requirements of each regulator.

2.6 FILTERS

A. Coalescing Filters

1. Acceptable Manufacturers: Balston, Dominick Hunter, Matheson, Pall, or approved equal
2. Filter element shall be 99.99% efficient at 0.1 micron and capable of [XXX] scfm at [XXX] psig with [XXX] psig pressure drop when clean.
3. Filter housing shall be stainless steel with auto-drain device, viton seals, and be rated for 250 psig working pressure. Pipe discharge from auto-drain to nearest floor drain. Housing shall be cleaned and bagged for oxygen service
4. Balston Grade BX with Model 45S6 housing.

B. Particulate Filter

1. Acceptable Manufacturers: Balston, Dominick Hunter, Matheson, Pall, or approved equal
2. Filter element shall be 99.99% efficient at 0.1 micron and capable of [XXX] scfm at [XXX] psig with [XXX] psig pressure drop when clean.
3. Filter housing shall be stainless steel with viton seals and be rated for 250 psig working pressure.
4. Balston Grade AQ with Model 45S6 housing.

2.7 SPECIAL GAS MANIFOLDS

A. Argon, Helium, Helium, Nitrogen and Oxygen

1. Acceptable manufacturers: AGA/Linde, Concoa, Matheson, Linde Electronics and Specialty Gases
2. Manifolds shall be high-purity semi - automatic style suitable for gas purities up to 99.999 percent and be cleaned for oxygen service. Manifold shall accommodate primary cylinders and secondary cylinders, quantity per Lab Drawings, with automatic changeover from primary cylinders to secondary cylinders. Manifolds shall include:
   a. Regulators shall be manufactured from high purity stainless steel barstock materials and contain a stainless steel diaphragms.
   b. Manifolds shall be suitable for inlet pressures up to 3000 psig and deliver gas in the range of 0-125 psig.
   c. Manifolds shall be equipped with purge valves to allow purging of cylinders while in use. Flow limiters shall be provided on purge lines.
   d. All manifold valves shall be 1/4 turn ball valves.
   e. Manifolds shall include stainless steel braided flexible connectors with appropriate CGA fittings.
   f. Manifolds shall have gauges with inductive style contacts for alarm signals.
   g. Relief valve for protection of manifold from overpressure. Relief valve shall accommodate maximum flow from failed regulator while maintaining system pressure or below design pressure.

3. Changeover from primary to secondary supply shall take place automatically when primary supply becomes depleted. When depleted bank of cylinders is replenished, actuation of a clearly marked, easily operable lever on each bank regulator shall cause replenished bank to become secondary or reserve supply without requiring opening or closing of multiple bypass valves. Repositioning of operating levers shall expose indicator labels that clearly

show if manifold has been properly reset and which bank is primary supply and which is secondary supply.

4. Basis of Design: AGA/Linde Model A208
5. Manifold shall be set to deliver gas at listed pressures:
   a. Argon: 55 psig
   b. Helium: 55 psig
   c. Nitrogen: 55 psig
   d. Oxygen: 55 psig

B. Gaseous Carbon Dioxide

1. Acceptable manufacturers: AGA/Linde, Concoa, Chart, Matheson, Linde Electronics and Specialty Gases
2. Manifolds shall be high-purity semi - automatic style suitable for gas purities up to 99.999 percent. Manifold shall accommodate two primary cylinders and[two secondary cylinders with automatic changeover from primary cylinders to secondary cylinders. Manifolds shall include:
   a. Regulators shall be manufactured from high purity brass barstock materials and contain a brass diaphragms.
   b. Manifolds shall deliver up to 1200 scfh C02 at an outlet pressure of 75 psig.
   c. All manifold valves shall be 1/4 turn diaphragm style with stainless steel diaphragm
   d. Manifolds shall include stainless steel [braided flexible connectors] [pigtails] with appropriate CGA fittings.
   e. Manifolds shall have inductive style contact gauges to be used by alarm system if required.
   f. The manifolds shall incorporate an economizer gas control circuit.
   g. The manifold shall incorporate 1000 watt gas heaters to prevent regulator malfunctions.

3. Changeover from primary to secondary supply shall take place automatically when primary supply becomes depleted. When depleted bank of cylinders is replenished, actuation of a clearly marked, easily operable lever on each bank regulator shall cause replenished bank to become secondary or reserve supply without requiring opening or closing of multiple bypass valves. Repositioning of operating levers shall expose indicator labels that clearly show if manifold has been properly reset and which bank is primary supply and which is secondary supply.
4. Basis of Design: AGA/Linde ModelSMD50-C02-Econ-2
5. Manifold shall be set to deliver CO_2 at 75 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Nitrogen and Carbon Dioxide Piping: Gaseous nitrogen and carbon dioxide piping shall be installed according to requirements of CGA pamphlets and as shown on drawings.

B. Piping shall be installed above ground in buildings. Protect pipe openings during construction to prevent introduction of dirt and debris.

C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from each piece of equipment.

D. Identify gas services during installation so that the chance for cross over of one gas service to a different terminal unit is avoided. Do not depend on test procedure listed herein to identify cross connections.

E. Manifold relief valves shall be piped to exterior or other appropriate points. Avoid discharging close to windows, doors and air intake louvers.

F. Changes in direction shall be made by use of fittings. No pipe bending allowed. Pipe size reductions shall be by use of reducing fittings, no bushings allowed.

3.2 UNDERGROUND WARNING TAPE

A. Provide warning tape for exterior buried compressed gas lines per Section 20 0553.

3.3 COPPER TUBING

A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.

B. Brazed Copper Joints:

1. Brazed joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1250ºF. Solder impurities shall not exceed 0.15%.
2. Tubing shall be delivered to site with original mill caps in place.
3. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
4. Joints shall be cleaned and polished before brazing.
5. Flux of any type shall not be used.
6. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
7. Purge tube with nitrogen during brazing procedure. Provide manual shut-off valve and check valve as required for purge gas.

3.4 STAINLESS STEEL

A. Swagelok fittings and tubing shall be installed according to manufacturer's recommendations.

3.5 CONTAINMENT PIPING

A. Containment piping shall be installed per manufacturer's recommendations.

B. Manufacturer's representative shall provide training on proper installation techniques for containment pipe and provide certification to Owner that instruction has been given and proficiency has been demonstrated by Contractor in installation of piping systems.

C. Containment pipe shall terminate 12" above finished grade and finished floor with water tight end connection.

D. Centralizer support spacing shall be per Section 20 0529 - Piping and Equipment Supporting Devices.

3.6 CLEANING

A. Piping and components that are provided "Cleaned for Oxygen Service" shall not require cleaning. Flush system with source gas until 100% concentration of service gas is verified at all outlets.

B. For components not provided "Cleaned for Oxygen Service" and components where cleanliness has been compromised, pipe and fittings shall be thoroughly cleansed of oil, grease, dirt or other contaminating materials by washing in a hot solution of sodium carbonate or trisodium phosphate mixing in proportions of 1 pound to 3 gallons of water. Scrubbing shall be employed where necessary to obtain complete cleaning. After washing, materials shall be rinsed thoroughly with clean hot water and dried with dry nitrogen. After cleaning, tubing, fittings, and valves shall be plugged or wrapped until item is to be installed. Particular care must be exercised in handling and in conditions of tools used to prevent oil and grease being introduced. If contamination has occurred, affected items must be rewashed.

C. Before actuation of gas supply, systems shall be flushed with dry nitrogen to ensure a clean system free of oil and construction debris. Nitrogen shall then be purged by source gas until 100% concentration of source gas is verified at all gas outlets for that service gas.

3.7 TESTING

A. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Pressurize piping system prior to connection of laboratory fixtures and check for leakage by examining each joint by means of Oxweld No. 23 Leak Test Solution or other non-frothing solutions approved for this purpose.

1. Gaseous carbon dioxide piping shall be pressurized with dry nitrogen at 150 psi.
2. Gaseous nitrogen system shall be pressurized with dry nitrogen at **[**150 psig**] [**300 psig**]**.
   a. Special gas piping systems shall be pressurized with oil free compressed air or dry nitrogen at 150 psig.

C. Test pressure shall remain in piping for at least 24 h. Source pressure shall be shut off and pipe temperature at beginning and end of test shall be recorded. Pressure changes, other than that caused by temperature change, will not be permitted.

D. Provide final pressure test at 100 psig for 8 h after connection of laboratory fixtures.

E. Test operation of pressure switches and verify that signals are properly transmitted.

F. Containment piping shall be pressurized with oil free compressed air at 5 psig for 2 h. Containment piping shall not be pressure tested until carrier pipe has passed pressure testing.

3.8 CERTIFICATION

A. Cross-over test shall be performed by independent testing agent hired by Contractor.

B. Testing agency shall certify that terminal units are connected to proper gas piping system. Test shall be done in conformance with requirements of NFPA 99.

C. As part of certification test, all alarms should be actuated and checked for proper setting and wiring to alarm panels.

D. As a last check, special gas systems shall be purged of test gas and oxygen terminal units shall be analyzed to insure proper oxygen concentration is delivered through each oxygen terminal unit.

E. Certification test report shall be submitted to Architect and Engineer for review prior to use of special gas systems. Systems shall not be considered in service until satisfactory test results are submitted and approved.

3.9 HIGH PURITY GAS QUALITY CERTIFICATION

A. Particulate Testing

1. Establish background count by connecting particle counter to 0.1 micron filter and record number of counts per volume. Background counting shall begin at least 8 h prior to final particulate analysis.
2. Test system by withdrawing sample from each terminal point in system. Samples shall be taken by connecting particle counter to system using VCR type face seal fitting. Sample gas flow shall be sufficient to produce and maintain turbulent flow, i.e., maintain a Reynolds number greater than 4000.
3. Duration of test at each terminal point shall be such that 10 scf of gas or 10 minutes of time elapses, whichever is greater. Test shall be considered failed if sampled gas does not fall within limits within 30 scf of gas or 30 minutes, whichever is greater.
   a. Failed lines shall be purged and testing defined herein shall be repeated until acceptable results are obtained.

4. Acceptable particle test results:

a.	0.01 micron	<50 per 1 scf
b.	0.1 micron	<10 per 1 scf
c.	0.2 micron	<5 per 1 scf
d.	0.3 micron and larger	0

B. Gas Purity Testing

1. Gas purity testing shall be performed to detect residual moisture, oxygen, and total hydrocarbon content. Test shall be done with nitrogen filtered to 0.01 microns. Source gas shall be certified by supplier as having no impurities in excess of 5 ppm moisture and 1 ppm oxygen and hydrocarbon content. Purge gas source shall be tested prior to use as trace gas.
2. Nitrogen shall flow continuously during sample period at no greater than 10 scfh to eliminate dilution of sample contamination.
3. System shall be certified as acceptable if change increase from source gas to sample point of each impurity does not exceed following levels:

a.	Oxygen	<1 ppm
b.	Moisture	<2 ppm
c.	Total hydrocarbon content	<1 ppm

4. Duration of test at each test point shall be such that 10 scf of nitrogen or 10 minutes time elapses, whichever is greater. Test shall be considered failed if sample does not fall within limits within 30 scf of nitrogen or 30 minutes, whichever is greater.
   a. Failed lines shall be purged and testing defined herein shall be repeated until acceptable results are obtained.

5. Test analyzer shall be calibrated prior to use. Certification of calibration shall be provided to Owner and copy to be retained with analyzer at all times.
6. Test shall be performed on each terminal outlet.

END OF SECTION 220594

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SECTION 226653 - CORROSION RESISTANT WASTE AND VENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies pipe, fittings, equipment and methods for corrosion resistant waste and vent piping system installed to 5 ft outside the building wall.

1.2 RELATED WORK

A. Section 20 0520 - Excavation and Backfill

B. Section 20 0529 - Piping and Equipment Supporting Devices

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements**.**

1.4 SUBMITTALS

A. Shop drawings on items specified herein.

B. Submit Manufacturer's technical data for the following:

1. Pipe and fittings
2. Joints
3. Floor drains
4. Cleanouts

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new materials unless otherwise noted.

2.2 PIPE

A. Underground:

1. Chlorinated Polyvinyl Chloride (CPVC)

a. Pipe: Schedule 40, ASTM D1784, and ASTM F2618

b. Fittings: Drain, waste, and vent (DWV) pattern, ASTM D3311

c. Joints: Solvent cement, ASTM F493

~~A.~~**d. Manufacturers: Charlotte "ChemDrain", Spears "LabWaste"**

~~1. Polypropylene (PP)~~

~~a. Pipe: PP, Schedule 40, non-flame retardant, ASTM D4101, plain end~~

~~b. Fittings: PP, Schedule 40, non-flame retardant, drainage pattern, electrofusion~~

~~c. Joints: Electrofusion~~

~~d. Manufacturers: Georg Fischer "Fuseal", Ipex "Enfield", Orion "Rionfuse", Zurn~~

B. Above Ground:

1. Chlorinated Polyvinyl Chloride (CPVC)

a. Pipe: Schedule 40, ASTM D1784, and ASTM F2618

b. Fittings: Drain, waste, and vent (DWV) pattern, ASTM D3311

c. Joints: Solvent cement, ASTM F493

d. Manufacturers: Charlotte "ChemDrain", Spears "LabWaste"

~~B.~~

~~1. Polypropylene (PP)~~

~~a. Pipe: PP, Schedule 40, ASTM D4101, flame retardant in conformance with ASTM D635, grooved end~~

~~b. Fittings: PP, Schedule 40, flame retardant in conformance with ASTM D635, drainage pattern, mechanical joint~~

~~c. Joints: Mechanical~~

~~d. Manufacturers: Georg Fischer "Fuseal MJ", Ipex "Labline", Zurn~~

2.3 ADAPTERS

A. Provide where indicated and as necessary; glass to plastic compression coupling, plastic to metal mechanical joint, or glass to metal mechanical joint and/or compression coupling.

B. Plastic to plastic 1" through 4": Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless steel clamping bands.

C. Submit adapter fittings for approval prior to installation.

2.4 CLEANOUTS

A. Corrosion resistant materials similar to piping materials. ~~Refer to Cleanout Schedule on drawings.~~

2.5 FLOOR DRAINS

A. Refer to Drain and Cleanout Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping neat and orderly; accomplish changes of direction using proper pipe fittings. Connect to sinks, cup sinks, floor drains, and other devices as shown on drawings. Conceal piping unless noted to be exposed in reagent rack. Piping within casework shall be coordinated with casework supplier.

B. Pitch vent piping to waste line. Install horizontal waste piping with minimum pitch of 1" in 4 ft; except piping 3" and larger may pitch 1" in 8 ft. Make changes in direction of flow by use of drainage pattern fittings.

C. Set floor drains level and at low points. Protect weep holes from filling with concrete. Clamp safing to drain body for proper drainage.

D. Install cleanouts as shown on drawings. Locate cleanout access cover so that snake of100 ft can be properly used.

E. Provide caps and plugs on open pipe ends during construction phase to prevent construction debris from entering pipe.

F. Provide necessary transition fitting and couplings required when changing from one piping material to dissimilar material.

3.2 PLASTIC PIPING

A. Install plastic pipe and fittings as recommended by respective manufacturer. Fuse plastic pipe joints with surrounding temperature above freezing using equipment supplied by pipe manufacturer. Adhere to instructions for fusing as published by manufacturer. Instructions for fusing shall be kept on site.

~~B. Install mechanical joints in accordance with instructions from pipe/fitting manufacturer. Use materials of same manufacturer, especially made for mechanical jointing. Use pipe and fittings with factory cut groove, except pipe may be grooved in field using equipment and methods as recommended by manufacturer of pipe. Use hangers on each side of mechanical couplings.~~

~~C.~~**B.** Manufacturer's representative shall instruct workmen in proper installation techniques required for ~~XXX~~ **installation of the corrosion resistant waste and vent system** and provide certification to Owner that instruction has been given and proficiency demonstrated by Contractor in execution of installation of piping system.

~~D. Do not install PP material in plenum space. Refer to HVAC drawings to determine plenum spaces.~~

~~E.~~**C.** Use special precautions and approved/listed systems when ~~PP~~ **CPVC** material penetrates fire resistive or smoke barrier. Refer to Section 20 0573 - Mechanical Systems Firestopping.

~~F.~~**D.** Do not use plastic pipe when high temperature (above 100°F) water (at autoclaves, sterilizers, glasswashers, and similar devices) is discharged to receptor or drain. Provide minimum of 25 ft of PVDF or stainless steel piping material downstream of high temperature drain discharge point.

3.3 TESTING

A. Refer to Testing paragraph of Section 20 0000 - General Mechanical Requirements.

B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not backfill pipe until successfully tested.

E. Testing with air will not be allowed.

3.4 CLEANING

A. After successful pressure test, clean and flush piping system to eliminate debris in drainage system.

END OF SECTION 226653

SECTION 226714.13 - PLASTIC PIPING FOR HIGH PURITY SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers requirements for procurement, installation, inspection, and sanitization of Low-Extractable Polyvinylchloride (LXT) piping, fittings, valves, and specialties for Pure Water (PW) service.

B. HPW system is defined by:

1. This document
2. Flow diagrams XXX, XXX, XXX
3. Sections under Related Work below.
4. Piping Plan drawings XXX, XXX

C. HPW piping is defined as piping downstream of RO system.

1.2 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 20 0573 - Mechanical Systems Firestopping

C. Section 22 6720.13 - High Purity Water System Equipment

1.3 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.4 SCOPE OF WORK

A. Contractor shall be responsible for procurement, installation, inspection, and sanitization of piping system.

B. Contractor shall provide personnel trained and experienced in installation of selected manufacturer's piping system. If personnel are not experienced at start of installation, piping manufacturer's representative shall train Contractor prior to installation. Training certification and experience record is required.

C. Contractor shall submit documentation on components proposed for system and shall obtain approval prior to purchase or fabrication of those components.

D. Contractor shall inspect system and provide documentation to demonstrate that system is installed according to Specification, is leak free, and has been sanitized according to procedure.

1.5 BASIS OF DESIGN

A. Service: PW

1. Process Fluids: pure water
2. Operating Pressure/Temp 100 psig at 80°F
3. Piping System
   a. Design Pressure: 144 psig at 68°F for components
   b. Material: LXT
      1). Joining method: socket fusion
      2). Elastomer: Viton

B. Service: PW water

1. Process Fluids: water with resistivity of XX megohm
2. Operating Pressure/Temp. 100 psig at 80°F
3. Piping System
   a. Design Pressure: 150 psig at 100°F for components
   b. Material: LXT
      1). Joining method: Solvent weld
      2). Elastomer: EPDM

1.6 SUBMITTALS

A. The following items must be submitted for review, and approved prior to purchase of item:

1. Detailed descriptions of pipe, fittings, valves, and other components.
2. Identification of joining method and fusion equipment.
3. Detailed Sanitization Procedure (see Part 3.1).
4. Training certification for installation personnel.
5. Isometric drawings of piping from RO unit through distribution equipment.

B. The following documentation is required to be delivered with system:

1. Pressure Test Report
2. Sanitization Records
3. Manufacturer's material certifications
4. Record of fusion machine operating parameters for every joint
5. Joint inspection records

1.7 DELIVERY

A. Pipe, fitting, and components shall be furnished with plastic end-caps/plugs to prevent contamination and damage.

B. Pipe, fitting, and components shall be furnished in individually sealed bags to prevent contamination.

C. Pipe, fittings, and components shall be handled and shipped so as to protect from contamination and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Spears Harvel LXT PVC

2.2 GENERAL

A. Piping, fittings, and valves that are to be heat fused shall be products of same manufacturer.

B. Piping, fittings, valves, gaskets and accessories shall be compatible with Design Conditions in Part 1.5 as stated above.

C. Dimensions of end connections for valves shall be compatible with pipe and fittings.

D. Materials in contact with water shall be FDA approved for sanitary product contact surfaces.

E. Pipe and fittings shall be permanently identified with production lot and wall thickness or pressure rating.

F. Piping, fittings, valves, and components shall be manufactured in dedicated equipment in clean environments and bagged.

G. Material Certification Documentation shall be furnished for piping, fittings, valves, and components.

2.3 PIPE, FITTINGS, & JOINTS

A. Harvel LXT PVC

1. Pipe: Low-extractable PVC, virgin material, Schedule 80, with cell classification per ASTM D1784
2. Fittings: Low-extractable PVC, Schedule 80, socket pattern, ASTM D2467
3. Joints: One-step solvent cement. Use of threaded fittings shall be limited to locations where equipment requires threaded connection.
4. Flanges: Low-extractable PVC, ANSI Class 150 bolt pattern, rated for 150 psig at 73°F.
5. Valves:
   a. Ball Valves: Low-extractable PVC body and ball, full port, PTFE seat, EPDM o-ring seats, true union ends, socket pattern, rated for 150 psig at 73°F.
   b. Diaphragm Valve: Low-extractable PVC body, PTFE diaphragm, EPDM o-ring seals, true union ends, socket pattern, rated for 150 psig at 73°F.
   c. Ball Check Valve: Low-extractable body and ball, EPDM o-ring seals, true union ends, socket pattern, rated for 150 psig at 73°F.

2.4 SPECIALTY ITEMS

A. Orifice Plates

1. Manufacturers: Rubber Fab Mold and Rubber Co., Newman Gasket Co., or Georg Fischer

2. Flow restriction orifice plates shall be 316L stainless steel with minimum finish of 25 Ra micro-inch, or Kynar, for installation in Tri-clamp or sanitary union.
3. Orifice plates shall be tagged with instrument number and orifice bore size.
4. Orifice plates shall be concentric or eccentric depending upon installation orientation
5. Preliminary sizing information is shown on P&ID. Sizing information shall be verified by Engineer after Contractor submits drawings.

B. Flexible Sections

1. Flexible sections indicated on drawings shall be **[convoluted] [smooth]** FDA Approved Teflon with external polypropylene reinforcing braiding and tri-clamp connections. Teflon inner core is extended through flange and flared to form gasket. Backing flange to be PVDF with 150 # ANSI dimensions. Flexible sections shall be rated for at least 150 psig.

C. Faucet Connections

1. Tubing for connection to lab faucets shall be polypropylene, or PFA tubing, 3/8” OD; 0.062” wall, rated to at least 150 psig at 80°F. Polypropylene tubing shall be made from virgin copolymer conforming to FDA requirements for food contact.

2.5 INSTRUMENTATION

A. Instrumentation Specifications are covered in Section 22 6720.13.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and inspect piping and accessories as per Contract Documents and recommendations of equipment manufacturers.

B. Provide installation personnel who are trained and experienced with assembly of selected piping in high purity systems.

C. Provide installation personnel who are certified by piping manufacturer for specified joining method.

D. Provide diaphragm valves or type of valves as indicated on drawings.

1. Inspect delivered components to verify conformance to specification and to check for evidence of damage or contamination. Do not use suspect materials.

E. Maintain high level of cleanliness during handling and installation.

1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
2. Handle and store tubing, fitting, and components in a manner that prevents impact damage, excessive stress, and contamination.
3. Maintain manufacturer's protective packaging in place until immediately prior to use.
4. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.

F. Install piping using minimum number of joints.

G. Monitor and inspect installation process to ensure:

1. Conformance with this Specification.
2. Compliance with manufacturer’s requirements.
3. Piping is supported as specified.

3.2 INSTALLATION

A. LXT Joint Fabrication

1. Perform joining in strict accordance with manufacturer's recommended procedures. Cut piping in strict accordance with manufacturer's recommended procedures.
2. Clean components prior to fusion conscientiously and in strict compliance with Manufacturer's recommendations for high purity services.
3. Form joints by solvent welding in accordance with ASTM D-2855, using solvent cement conforming to ASTM F-493 and to NSF International for use on potable water systems.
4. Use union joints only where indicated on drawings or where necessary to connect to accessories and equipment. Verify that o-ring is correctly indexed prior to tightening. Tighten hand tight only; do not use tools.
5. Tighten flanged connections in strict accordance with manufacturer's recommendations.
6. Use threaded connections only if there is no other option for connecting to equipment.

B. Configuration

1. Horizontal runs shall be continuously supported by equal leg aluminum, stainless steel, or galvanized steel "V" channel under pipe. Support tubing in strict accordance with manufacturer's recommendations for a maximum deflection of 0.01” per foot at operating temperature stated in part 1.5 above or 86°F, whichever is higher. In additional to these supports, supports shall be provided at all changes of direction.
2. Install tubing so that there are no undrainable pockets. Provide adequate support of pipe at pump discharge.
3. Orient diaphragm valves per manufacturer's instructions to ensure complete drainage.
4. Install check valves and orifice plates in vertical sections. If installation in horizontal is required, provide eccentric valve or plate and orientate properly.
5. Provide low point drains and high point vents in compliance with drawings and Engineering review of isometric drawings.
6. Rough or sharp edges must not be in contact with pipe.
7. Erect tubing without spring or force. Connect to equipment such that stress is not transferred to equipment.
8. Install all tee connections so as to minimize dead leg. Distance from sealing point on branch to inside of main line wall shall be less than **[four]** branch line diameters.
9. Route lines so as to accommodate thermal expansion where required. Provide supports appropriate for thermal expansion. Install supports so that movement of piping due to thermal expansion is not impeded.

C. In-Line Devices

1. Locate and orient in-line specialty items and instrumentation so as to allow for access after insulation is installed, including:
   a. Access for maintenance and calibration.
   b. Viewing of gauges by operating personnel.

c. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
d. Convenient operator access to sample valves and insertion of sampling container.

2. Install in-line specialty items and instruments such that they are free draining.
   a. Install restriction orifices in vertical section of pipe unless. If orifice must be in horizontal run, use an orifice that is eccentric drilled and orientate with hole at low point.
   b. Install in-line specialty items and instruments in strict accordance with manufacturer's instructions.
   c. Install sensors for conductivity and resistivity in run of a horizontal tee with flow exiting upward branch.
   d. Provide length of straight pipe upstream and downstream of flowmeters. As specified by manufacturer.
   e. Install pressure regulators and backpressure regulators with at least 10 pipe diameters of straight pipe upstream and downstream of regulator.
   f. Install sanitary orifice plates in sanitary unions or in Tri-Clamp joints as indicated on drawings. Clearly tag orifice location.
   g. Securely support relief valves and relief discharge lines.

D. Penetrations

1. Floor
   a. Provide sleeves on piping penetrations through floor slabs one pipe size larger than service piping, and extend sleeve 2" above finished floor.

2. Fire-Rated walls:
   a. Provide firestopping per Section 20 0700 - Mechanical Systems Firestopping.

3.3 USE POINT CONNECTIONS

A. Faucets

1. Install zero-static tee diaphragm valve with 13 mm(1/2") outlet port in loop line
2. Connect outlet of valve to faucet with 3/8" polypropylene or PFA tubing.
3. Use shortest length of tubing as possible.

B. Equipment

1. Install zero-static tee diaphragm valve on distribution line with outlet size indicated on distribution drawing
2. Install piping per size from valve to equipment.
3. Install Restriction Orifice if indicated on drawing.
   a. Use concentric plate in vertical lines.
   b. Use eccentric plate in horizontal lines.

3.4 TESTING

A. Inspection

1. Visually inspect all joints and verify that they comply with manufacturer's criteria for a properly formed joint.
2. For joints fused by machines that generate labels, verify that each joint has label.
3. Check diaphragm valve bonnet bolts for correct torque.

B. Hydrotest

1. Execute all pressure testing safely.
   a. Do not pressurize plastic piping with gas.
   b. Isolate equipment or instrumentation that cannot to be exposed to test pressure.
   c. Notify personnel with access to system that testing is to take place. Tag each use point to indicate that valve is not to be used.
   d. Ensure that air is completely vented from system to avoid a hazardous condition.
   e. Pressurize system gradually.
   f. Provide controls to prevent pressure from exceeding specified test pressure.

2. Ensure that cleanliness of system is not compromised.
   a. Provide water for testing and flushing that has quality equal to or better then service water.
   b. When performing preliminary testing of sections of system, after test is complete flush all water out of system and ensure that it drains completely. Close all openings in system after draining.

3. Execute final acceptance test on completed piping system.
   a. Do not insulate or conceal piping until testing is complete.
   b. Test system in sections or as a whole, but all joints need to be covered in test.
   c. Ensure that air is completely vented from system.
   d. Pressurize gradually and hold system at 100 psig for 4 hours. An initial pressure decrease will occur due to pipe elongation after pressurization. After 4 hours, pressure loss will stabilize, and pressure must then hold at test pressure without a loss of 1% over period of one hour to pass test.
   e. Monitor pressure with gauge located near bottom of system that is readable to at least plus or minus 1 psi.
   f. Note if pressure drops more than 1% over test period and determine source of leakage.
      1). Cut out and reinstall defective joints.
      2). Hand tighten wing nuts on sanitary clamps if required. If leakage continues, install new gasket. Do not tighten using tools.
      3). Retest.

4. Provide written certification that includes identification of portion of system tested, date, time, test criteria, test medium and pressure, duration, and name and title of person responsible for test.

3.5 SANITIZING/FLUSHING

A. General

1. Perform sanitization after inspection, documentation, and acceptance of system. If chemical sanitation is not required then this procedure will be used for flushing, without addition of sanitant.

2. Prior to sanitization, slowly fill system with water while venting air from system. Continue to check that all air has been vented after water is recirculating.
3. Adjust any pressure regulators to their preliminary setpoints.
4. Perform sanitization immediately prior to placing system in operation and coordinate with Owner's representative.
5. Safety:
   a. Follow manufacturer's safety recommendations for handling of chemicals.
   b. Disconnect power to UV lights prior to sanitization.
   c. Provide controls to ensure that system remains within pre-established sanitization conditions and that system pressure does not exceed Design Conditions in Part 1.5 above.
   d. Ensure that proper chemicals are used and that they are handled safely.
   e. Notify personnel with access to system that sanitation is being performed. Prior to cleaning, tag each use point to indicate that valve is not to be used.

6. Provide all equipment, fittings, and supplies necessary to execute sanitization.
7. Prepare a procedure which identifies:
   a. Recirculation circuit**(s)** and sampling points.
   b. Measures required to confine sanitizing solution.
   c. Step-by-step procedure (including any modifications to piping or controls).
   d. Sign-off matrix.

8. Isolate equipment or instrumentation that is not to be exposed to sanitant.
   a. Bypass ion exchange beds.
   b. Turn off UV lights.
   c. Record all changes made to system that are required to execute test.

9. Record execution of procedure including Owner sign-off.

B. Procedure for hydrogen peroxide

1. Makeup solution of 5% hydrogen peroxide with water. Water shall be equivalent to service water quality or deionized water (minimum 1 megohm) that has passed through a 1.0 micron filter.
2. Fill entire system with solution. All gas must be vented, and system set up for recirculation so that all parts will be exposed to solution.
3. Recirculate at flow rate of at least 3 fps. Draw samples at points of use and at other key sample points to confirm presence and concentration of peroxide.
4. Confirm that there is solution throughout system, and then continue to recirculate for at least 4 h. Draw off water for at least one minute at each use point.
5. After recirculation with solution flush system with product quality water for at least 45 minutes, rotating draw off from all use points.
6. Test water with solution residual test strips at key sample points to ensure less than 1 ppm is achieved.
7. Continue to flush for 30 minutes. Draw off water for at least 1 minute at each use point.
8. Return system to its original configuration. Verify that all modifications that were made to piping or controls were restored. Prepare system for normal operation.

C. Procedure for peracetic acid [Minncare or approved equal]

1. Makeup solution of 1% Minncare with water that is less than 70°F. Water shall be equivalent to service water quality or deionized water (minimum 1 megohm) that has

passed through a 1.0 micron filter. Fill entire system with solution. All gas must be vented, and system set up for recirculation so that all parts will be exposed to solution.

2. Recirculate at flow rate of at least 3 fps. Draw samples at points of use and at other key sample points to confirm presence and concentration of peracetic acid solution using test strips. Monitor system temperature to ensure that is does not rise above 75°F.
3. Confirm that there is solution throughout system, and then continue to recirculate for at least 3 h. Draw off water for at least one minute at each use point.
4. After recirculation with peracetic acid solution flush system with product quality water for at least 45 minutes, rotating draw off from all use points.
5. Test water with peracetic acid solution residual test strips at key sample points to ensure less than 1 ppm is achieved.
6. Continue to flush for 30 minutes. Draw off water for at least 1 minute at each use point.
7. Return system to its original configuration. Verify that all modifications that were made to piping or controls were restored. Prepare system for normal operation.

END OF SECTION 226714.13

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SECTION 226720.13 - HIGH PURITY WATER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the system for production and distribution of High Purity Water (HPW). Note these specifications are a guideline which may be modified to achieve product production and distribution goals. The vendor is encouraged to contact the engineer and further develop the specifications and drawings to reflect a system with a more off the shelf nature rather than purely a custom system. The final system shall be supportable by a "local" vendor, producing, storing and distributing the quantity of ASTM type II water with no biological specification.

B. Complete specification of the system is defined by:

1. This Section
2. Sections listed under Related Work below,
3. **~~[P&ID]~~[**Flow Diagrams**~~]~~** on drawings**: ~~XXX~~ P-506**
4. Equipment layout on drawing**: ~~XXX~~P-401**

1.2 SCOPE

A. Contractor's Scope of Work includes:

1. Subcontracting with an acceptable water treatment equipment vendor (Vendor) and managing Vendor's scope of work and performance. Coordinating:
   a. Size of equipment and skids with delivery schedule to ensure that equipment can be moved into place.
   b. A drawing showing layout of equipment positioned in Owner's area.
   c. Identification of all field installation of piping and wiring interconnections required between Vendor's equipment.

2. Installation of Vendor's equipment and providing utilities to equipment.
   a. Providing piping and wiring interconnections between Vendor equipment as required.

3. Providing distribution piping.
4. Coordination of startup and system Turnover with Owner to ensure system is always actively managed.

B. Vendor's Scope of Work includes furnishing:

1. A complete system, as defined in this document. Note that the contract documents are a performance contract for the system.
2. Detailed drawings and instructions to Contractor for installation for field piping and wiring interconnections required between Vendor's equipment and components.
3. Documentation
4. Sanitization of system
5. On-site support checkout, startup, and testing
6. Demonstration that system meets quality and operational requirements
7. On-site training
8. Operation of system until turnover to Owner

1.3 RELATED WORK

A. HPW system shall meet requirements of following Sections:

1. Section 20 0513 - Motors
2. Section 22 6714.13 - Plastic Piping for High Purity Service

1.4 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including. General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.5 BASIS OF DESIGN

A. Vendor is responsible for providing system that consistently and reliably delivers water of the following quality to the supply of distribution loop piping.

1. If Vendor believes that system design specified herein will not meet the quality standards, Vendor shall notify Engineer.

B. Water Quality Requirements

1. System shall provide water meeting specifications of American Society of Testing and Materials (ASTM) Type II Reagent Grade Water. Specification is:
   a. Conductivity: ≤ 1.0 micro siemens/cm (25°C)
   b. Resistivity: ≥ 1.0 megohms - cm (25°C)
   c. pH: NA
   d. TOC: ≤ 50 micrograms/liter
   e. Sodium: ≤ 5 micrograms/liter
   f. Chlorides: ≤ 5 micrograms/liter
   g. Total silica: ≤ 3 micrograms/liter
   h. Microbial Level: none

C. Supply Water Quality

1. Vendor is responsible for providing suppling a water analysis and notifying Engineer if quality is such that **special treatment is required, e.g. high silica, or iron requiring a green sand filter**.
2. Minimum temperature of supply water: **70~~[XXX]°C(~~**°F~~)~~
3. Minimum pressure of supply water: **20 ~~[XXX]~~ kPa~~(~~**psig~~)~~
4. Maximum pressure of supply water: **70 ~~[XXX]~~ kPa~~(~~**psig~~)~~
5. Water production system shall be designed to produce required water quality based on maximum values from– **a** ~~following~~ water supply analysis **containing the following elements. This form is a sample only.**~~.~~

Water Source: City of ~~XXX~~ **Lakeland** - Variable Source				
Analysis				
Constituent	Average		Maximum	
Residual Chlorine, Total	**[XXX]**	mg/L	**[XXX]**	mg/L
Residual Chloramine	**[XXX]**	mg/L	**[XXX]**	mg/L
PH	**[XXX]**		**[XXX]**	
Total Alkalinity	**[XXX]**	mg/L	**[XXX]**	mg/L

Water Source: City of ~~XXX~~ **Lakeland** - Variable Source				
Analysis				
Constituent	Average		Maximum	
Total Hardness	**[XXX]**	mg/L	**[XXX]**	mg/L
Total Dissolved Solids (TDS)	**[XXX]**	mg/L	**[XXX]**	mg/L
Conductivity	**[XXX]**	umhos	**[XXX]**	umhos
Turbidity	**[XXX]**	NTU's	**[XXX]**	NTU's
Total Organic Carbon TOC	**[XXX]**	mg/L	**[XXX]**	mg/L
Magnesium	**[XXX]**	mg/L	**[XXX]**	mg/L
Potassium	**[XXX]**	mg/L	**[XXX]**	mg/L
Sodium	**[XXX]**	mg/L	**[XXX]**	mg/L
Silica (SiO2)	**[XXX]**	mg/L	**[XXX]**	mg/L
Chloride	**[XXX]**	mg/L	**[XXX]**	mg/L
Nitrogen (Nitrate)	**[XXX]**	mg/L	**[XXX]**	mg/L
Phosphate (PO4	**[XXX]**	mg/L	**[XXX]**	mg/L
Sulfate (SO4)	**[XXX]**	mg/L	**[XXX]**	mg/L
Trihalomethanes	**[XXX]**	ug/L	**[XXX]**	ug/L

D. Capacity Requirements

1. System shall produce 10 gpm of water of quality stated above.
2. Individual equipment shall comply with capacity and efficiency requirements stated below.

E. Size Requirements

1. Equipment shall be located in area shown on drawings referenced in Part 1.1. Location and sizes of equipment shown in those areas are preliminary **and for price estimating only**.
2. Contractor shall work with Vendor to determine equipment layout and submit an accurate drawing indicating positions of equipment in the area.
3. Layout shall ensure:
   a. Selected equipment and skid sizes will be able to pass through available building opening and passageways, or must be delivered prior to completion of that area of building.
   b. Proper access to HPW equipment and instrumentation for operations and maintenance.
   c. Compatibility with floor drains shown on drawings.
   d. Clearance for removal of regularly replaced components (filter elements, UV lamps, etc.)
   e. Access to tank manway and components on top of tank.

F. Site Conditions

1. Seismic Zone: 0
2. System location: mechanical room**.**
3. Electrical classification: non-hazardous

1.6 DOCUMENTATION

A. The following documents shall be furnished as follows:

	Submit For Approval	Upon Delivery	Turn Over Package
Production flow rates; flows to drain	X		
Piping and Instrumentation Diagram (P&ID)	X	X	As built
Pump Curves with Operating Points	X		X
Utility Loads	X		X
Drawing of system in facility space	X		
Instructions for Rigging, Storage, and Anchoring		X	
Instructions for extended storage of system, if necessary		X	
Detailed Equipment drawings	X	X	X
Equipment List	X		X
Descriptions of equipment and components.	X		X
Instrument List	X		X
Instrument Cut sheets	X		X
I/O List	X	X	X
Calibration Certifications		X	X
Operational and control description and functions	X		
Functional Specification	X	X	As built
Loop Diagrams		X	X
Control Schematics		X	X
Control Panel wiring drawings		X	As built
Component Cut Sheets	X		X
PLC Program Printout and Disk File			As built
OIT Configuration		X	As built
Electrical single line diagrams	X	X	X
Schematic wiring diagrams		X	X
Electrical panel drawings		X	X
Sanitization Procedure	X	X	
Acceptance Test Procedures		X	

	Submit For Approval	Upon Delivery	Turn Over Package
Acceptance Test Report			X
Water sampling results			X
O & M Manuals		X	As built
Training Program Outline		X	
Service Agreement Proposal		X	

1.7 WATER TREATMENT EQUIPMENT VENDORS

A. Acceptable Vendors: Evoqua Water Technologies, Marlo, Culligan Water Technologies , US Water Services or approved equal

1.8 DELIVERY

A. Vendor shall provide complete instructions on handling, rigging, anchoring, and on-site reassembly with unit.

B. Vendor is responsible for packaging to ensure unit arrives undamaged and uncontaminated.

1. Nozzles shall have covers which protect the face from damage and seal system from contamination.
2. Parts shipped loose shall be boxed and properly identified with durable, waterproof shipping tags attached with stainless steel wire or plastic tie strips. Parts shall be match marked for easy reassembly at site.

1.9 WARRANTY

A. System components shall be warranted from defects in materials and workmanship by respective manufacturer for period of 1 year from date of acceptance of system by Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. For equipment that is skid mounted:

1. Size of skid must be compatible with building dimensions and/or delivery must be coordinated with construction schedule to ensure that skid can be moved into building and set in place.
2. Skid size and dimension must be compatible with room layout.
3. Skids shall conform to AISC Manual of Steel Construction.
4. Skid construction shall comply with local and state code seismic requirements.
5. Single connection for each utility and for drain shall be provided.
6. Frame to be stainless steel or carbon steel with 2 coats epoxy paint.
7. Frame shall adequately support system components at their operating weights.
8. Surfaces that allow water to pool on part of frame are not permitted.
9. Skids shall be designed so that they may be lifted by both forklift truck and overhead crane.
10. Vendor shall inform contractor of field work required to assemble and interconnect skids.

2.2 COMPONENTS

1. The following components are provided as basis of design for pricing purposes only. The selected equipment vendor shall size and select all components necessary based upon an analysis of the water supply and the production and distribution criteria provided in these contract documents. Inclusion or exclusion of particular equipment in the following is not intended to be binding, this is a performance contract.

2.3 CARTRIDGE FILTERS

A. Description: Cartridge filter housing with hydrophilic cartridges for water filtration.

B. Acceptable Manufacturers: Ametek, Pall, Millipore, Sartorius or approved equal

C. Design flow: ~~**15**~~**40** ~~**[XXX] L/s(**~~gpm~~**)**~~ for each filter housing

D. Filter rating: ~~**[**~~10 micron~~**][XXX]**~~

E. Pressure Drop: ~~**[20.7 kPa(**~~3 psi~~**)] [XXX]**~~ at design flow

F. Housing Pressure Rating: ~~**860 kPa(**~~125 psig~~**)**~~

G. Pressure gauges shall be provided before and after unit.

H. Sample valve shall be provided after unit.

2.4 WATER SOFTENER

A. Unit shall be comprised of single water softener tank[s], complete with piping, automatic brass control valves, controller, pressure gauges, sample valves, resin, gravel, outlet "Y" strainer, dry-brine tank and brine eductor. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately.

B. Design Criteria

1. Each tank shall be sized to handle the service flow rate with the following criteria:
2. Service flow: 25 gpm
3. Volumetric Flow Rate: less than 3 gpm/ft^3 at service flow rate
4. Velocity: greater than 2.5 gpm/ft^2
5. Normal hardness leakage: Less than 1 ppm as $CaCO_3$
6. Endpoint effluent hardness: Less than 5ppm as $CaCO_3$
7. Back wash flow rate: 4 6 gpm/ft^2
8. Type: Resin Amberlite IR-120-Na (Rohm and Haas) or equal
9. Regenerant Chemical: saturated NaCl
10. Regenerant Quantity: 15 lb/ft^3 maximum
11. Regeneration Rate: 0.5 to 0.63 gpm/ft^2
12. Method of Chemical Introduction: Eductor
13. Capacity: 30,000 grams/ft^3 (as $CaCO_3$) at max salt dosage

C. Mechanical

1. Softener vessel
   a. Material: Fiberglass or epoxy coated carbon steel
   b. Pressure Rating/Test: 100/150 psig
   c. Temperature Rating: 120°F

d. ASME Code Stamped: No
e. Floor Support: Structural base
f. Piping Connections: threaded
g. Vessel internal distributors shall be PVC or ABS.
   1). Inlet Distributor (Top): Top inlet baffle
   2). Underdrain Distributor (Bottom): Hub radial with PVC laterals.
h. Access ports shall be provided in top head for control valve connection, media loading and removal.

2. Piping: Per referenced pipe section.
3. Y-Strainer: Bronze or PVC body with 20 mesh screen

D. Brine Tank:

1. Description: Dry-brine system with elevated grid plate
2. Quantity: 1
3. Material: Polyethylene
4. Salt Dose: 6-15 lb/ft^3 of softener resin

E. Controls

1. Motor-driven control valve shall stage each softener through regeneration steps. Regeneration shall be initiated by signal from alternator controller.
2. Regeneration frequency shall be based on throughput volume, totalized at common effluent.

F. Electrical: 120VAC, 1 Ph, 60 Hz power supply

G. Pressure gauges shall be provided before and after unit.

H. Sample valve shall be provided after unit.

2.5 CARBON FILTER

A. Unit shall be comprised of a single carbon filter, complete with piping, fully automatic brass motor driven multi-port control valve, pressure gauges, sample valves and media. Unit shall be preassembled, prewired, and hydrostatically tested. Media shall be packaged separately. **Note filter is to be sized for Chloramine removal.**

B. Design Criteria

1. Each bed shall be capable of handling the service flow rate with the following criteria:
2. Service flow: **~~[XXX] 2540 L/s(~~**gpm**~~)~~**
3. Flow Rate Criteria: less than **~~4.75 L/s/m²(~~**7 gpm/ft^2**~~)~~** at design flow rate
4. Backwash Flow Rate: **~~6.8 L/s/m²(~~**10 gpm/ft^2**~~)~~**
5. Fast Rinse Flow Rate: **~~3.4-6.8 L/s/m²(~~**5-10 gpm/ft^2**~~)~~**
6. **~~[~~**Chlorine Removal: 0.0 **~~mg/kg(~~**ppm**~~)~~** at carbon effluent**~~]~~**
7. **~~[~~**Chloramine Removal 0.0 **~~mg/kg(~~**ppm**~~)~~** at carbon effluent**~~]~~**
8. Clean Bed Pressure Drop: less than **~~35 kPa(~~**5 psig**~~)~~** at design flow rate

C. Mechanical

1. Vessel
   a. Material: Fiberglass

b. Pressure Rating/test: 100/150 psig
c. Temperature Rating: 120°F
d. ASME Code Stamped: No
e. Internal distributors:
1). Material: ———PVC or ABS
2). Inlet Distributor (Top): Top inlet baffle
3). Underdrain Distributor (Bottom): Hub radial with laterals
f. Access: ports in top head for control valve connection and media loading/removal.

2. Media: Acid washed Activated Carbon, Fine Gravel, Medium Gravel.
3. Piping:
a. As per referenced pipe Section.
b. Provide connections for sanitization.

D. Controls: Backwash frequency controlled by seven-day time clock. Operator shall have option to select day-of-week and time-of-day for backwash to occur.

E. Electrical: 120 VAC, single phase, 60 Hz

F. Pressure gauges shall be provided before and after unit.

G. Sample valve shall be provided after unit.

2.6 CARTRIDGE FILTERS

A. Description: Cartridge filter housing with hydrophilic, cartridges for water filtration.

B. Acceptable Manufacturers: Ametek, Pall, Millipore, Sartorius or approved equal

C. Design

1. Filter ~~F-**[XXX]**~~
a. Design flow: ~~[XXX]~~**40** ~~**L/s(**~~gpm~~**)**~~
b. Filter rating: ~~[XXX]~~**5** micron absolute
c. Pressure Drop: ~~**[20 kPa(**~~3 psig~~**)] [XXX]**~~ at design flow

~~2. Filter F-**[XXX]**~~
~~a. Design flow: **[XXX] L/s(**gpm**)**~~
~~b. Filter rating: **[XXX]** micron absolute~~
~~c. Pressure Drop: **[20 kPa(**3 psig**)] [XXX]** at design flow~~

D. Mechanical:

1. Housing Material: ~~[~~Polypropylene~~**] [316 stainless steel]**~~
2. Housing Pressure Rating: ~~**860 kPa(**~~125 psig~~**)**~~
3. Gasket Type: ~~[~~EPDM~~**] [Silicone]**~~
4. Connection Type: ~~[~~Flanged~~**] [Threaded]**~~

E. Instrumentation

1. Pressure indicators to be provided before and after unit. Sample valve to be provided after unit.

2.7 REVERSE OSMOSIS (RO) UNIT

A. RO unit shall be skid mounted, fully automatic, single pass system. Unit shall be preassembled, prewired, and hydrostatically and functionally tested.

B. Design Conditions

1. Design flow: 10 gpm permeate
2. Feedwater Temp: 72°F

C. Design Criteria

1. Max Average Permeate Flux/Element: 18 gfd (Gallons/ft^2/day)
2. System Recovery: 75%
3. Minimum Salt Rejection: 98% at stated recovery
4. RO Membranes:
   a. Type: Polyamide thin-film composite
   b. Manufacturer: Filmtec (Dow) or approved equal
   c. Minimum Salt Rejection: 98%

D. Instrumentation

1. The following instruments shall be provided:
   a. Conductivity sensors on feed and permeate. TDS monitor is not permitted.
   b. Pressure Indicating Transmitter on supply
   c. Flow Transmitter on permeate
   d. Flow Transmitter on reject
   e. High pressure switch on feed to membranes

E. Mechanical

1. Frame:
   a. System shall be supported by epoxy-coated frame, and designed to provide easy access for servicing, maintenance, and monitoring of operation.
   b. Piping shall be neatly arranged and supported on frame.
   c. Frame shall be designed for seismic zone indicated in Part 1.1 and shall offer maximum support and protection for system components.

2. RO Prefilter: 5 micron absolute, sized for max 3 psi pressure drop at maximum RO flow.
3. Valves:
   a. Automatic, pneumatically actuated, non-metallic, or stainless steel valve shall be provided in feed line.
   b. High pressure valves, including pump discharge throttling valve, reject throttling needle valve and reject recycle throttling needle valve shall be 316 stainless steel.
   c. Actuated flush valve shall be provided on a by-pass around reject throttle valve.
   d. Sample valves shall be provided on feed, product, and reject lines. Individual sample valve on product tubing of each pressure vessel shall be provided for analyzing system performance.
   e. Reject and reject recycle needle valves shall be mounted in close proximity to their respective flow rate indicators for ease of field adjustment.

4. Pressure gauges shall be furnished to monitor RO inlet pressure, pump suction pressure, membrane feed pressure, membrane reject pressure and RO product pressure.
5. Pressure Vessels:

a. Manufacturer: Advanced Structures, Inc. or approved equal
b. Material: FRP
c. Rating: 400 psig

6. Piping:
   a. Piping shall be designed for minimal removal during membrane loading.
   b. Nozzles shall be provided for connection of temporary lines for cleaning and sanitizing RO membranes and vessels.

7. Material and connections:
   a. Feed and Reject Pipe: Per referenced pipe section
   b. High Pressure Pipe: 316L stainless steel tubing
   c. Product Piping: Per referenced pipe section
   d. Pump: 316 stainless steel

F. Control System: Microprocessor or PLC based control system shall monitor and control operation of system and communicate with pretreatment equipment and distribution tank level as required. Skid mounted control panel shall house control system, operator interface controls, solenoids, IEC motor starter(s), step down transformer, high voltage disconnect. Control system shall be fully programmed and integrity tested at factory prior to shipment.

1. System shall provide the following functions
   a. On start-up, inlet valve should open prior to initiation of pump to completely fill the system with water.
   b. Upon shutdown of pump, actuated flush valve shall open for 3 minutes. After 3 minutes, flush valve and inlet valve shall close.
   c. Provide one discrete general fault signal for use.

2. Panel shall include:
   a. Lights, pushbuttons, and switches for status and control of system
   b. Conductivity monitor for feed and permeate
   c. Elapsed run time indicator
   d. Alarm horn
   e. System power switch
   f. Nameplates for device identification
   g. Automatic reject flush indicator and controls

3. Alarm conditions shall Include:
   a. Low feed pressure
   b. High and High High permeate conductivity

4. Unit Shutdowns include:
   a. Low feed pressure
   b. Pretreatment filters in backwash
   c. Product storage tank full
   d. High High permeate conductivity

5. Functional Specification
   a. Complete functional specification shall be provided which describes:
      1). operation of unit
      2). control loops
      3). interlocks
      4). alarms

5). startup/shutdown sequences
6). security

G. Electrical

1. RO unit shall have a single connection for 480 V, 3 phase power. Transformers for devices requiring other voltage shall be provided integral to skid.

2.8 MIXED BED DI COLUMNS - EXCHANGABLE

A. Description: Service exchange, mixed resin, ion exchange beds. Beds contain 60% anion/40% cation resin mixture, premium grade capable of producing 18 megohm water.

1. Design flow: 40 gpm
2. Design Criteria
   a. Volumetric Flow Rate: Less than 10 gpm/ft^3 at design flow
   b. Pressure Drop: Less than 5 psi per bed at design flow
   c. Cation Resin: Strong acid, hydrogen form
   d. Anion Resin: Strong base type 1, hydroxyl form
   e. Resin Capacity: 15,000 grains/ft^3
   f. Sodium Leakage: 0.1 ppm

B. Vendor shall provide beds in configuration shown on flow diagram in sufficient number to achieve design flow and criteria.

C. Mechanical

1. Vessels: fiberglass reinforced plastic (FRP) with vinyl ester lining and connections
2. Vessel Rating: 150 psig at 100°F
3. Hoses: polypropylene
4. Piping: as per referenced pipe Section

D. Instrumentation

1. Locate conductivity indicator after first set of beds
   a. Setpoint 1.5 megohm

2. Pressure gauges shall be provided before and after unit. Sample valve shall be provided after unit.

2.9 ELECTRODEIONIZATION UNIT

A. Description:

1. ElectroDeionization (EDI) System will be fully integrated and stand-alone unit comprised of EDI module, flow control module, concentrate recirculation system, monitoring and control instrumentation, power supply and controller.

B. Design Parameters

1. Resistivity of product water: 8 megohm minimum
2. Flow rate: 40 gpm
3. Pressure drop at design flow: less than 12 psi

C. Recovery: 90%

D. Electrical:

1. EDI unit shall be fed by ~~[240] [220] [~~120~~]~~ V, single phase.
2. Transformers for devices requiring additional voltage supply shall be provided with unit.
3. Instrumentation shall include monitoring of conductivity of product water.

2.10 CARTRIDGE FILTERS - HIGH PURITY

A. Description: T-style cartridge filter housing with hydrophilic, membrane pharmaceutical grade cartridges for water filtration

B. Acceptable Manufacturers: Pall, Millipore, Sartorius, or approved equal

C. Design Conditions

1. Filter
   a. Design flow: 40 gpm
   b. Filter rating: 0.1 micron absolute
   c. Pressure Drop: 2 psi at design flow

D. Mechanical:

1. Housing Material: 316 stainless steel, 25 Ra
2. Housing Pressure Rating: 145 psig
3. Gasket Type: FDA approved Silicone
4. Housing Configuration: T-style
5. Connection Type: Tri-clamp
6. Sample valves: Inlet and outlet
7. Drain valve: 1/2”

2.11 ULTRAVIOLET LIGHTS

A. Description: In-line Ultraviolet Lights

B. Acceptable Manufacturers: Neotech Aqua Solutions, UV Pure Technologies.

C. UV Design Conditions

1. Service: TOC reduction
2. Wavelength: 185 nm
3. Dosage: 30,000 microwatt-sec/cm^2 after 9,000 hours
4. Organics reduction: **99.9%**
5. Design Flow Rate: 40 gpm

D. Materials

1. Wetted surfaces: 316L stainless steel electropolished to a surface finish of 15 Ra and passivated.

E. Connections shall be flange .

F. Accessories: 2 "S" pattern light traps, 1 on inlet and 1 on outlet

G. Instrumentation

1. Temperature sensor with shut down interlock, local alarm, dry contacts.
2. UV intensity meter with local alarm and dry contacts.
3. LED operating indicators for each UV lamp.
4. Elapsed running time meter.
5. Remote start/stop capability.

H. Electrical: 120 VAC; single phase, 60 Hz

2.12 STORAGE TANK

A. Description: polyethylene, cylindrical, atmospheric, closed top tank with flanged and covered manway.

B. Acceptable Manufacturers: Snyder Tanks, Polyprocessing, Chemtainer, or approved equal

C. Capacity: **250** gallons nominal

D. Tank to be one piece, seamless construction of high density linear polyethylene.

E. Polyethylene to be FDA approved for food contact as per 21 CFR 177.1520. Resin complies with ASTM D-1998.

F. Design for at least 1.9 specific gravity. Temperature is 60° to 80°F.

G. Tank shall be air-tight

H. Cone or dish bottom shall be totally drainable.

I. Indoor location

J. Dished top head

K. Epoxy coated (2 coats) steel, or plastic support, so that bottom tank nozzle is at least 18” off of floor.

L. Nozzles:

1. Nozzles shall be welded inside and outside.
2. Nozzles shall all be flanged and gusseted.
3. A standard lid is unacceptable. Manway shall be flanged with gasketed, bolted cover.
4. Minimum size of nozzles is as per following schedule. Vendor is responsible to ensure adequate number and size of nozzles
5. Schedule

LOCATION	SERVICE	SIZE	CONNECTION	NOTES
Top	Manway	16” min.	flange	Replace standard access port with a flanged nozzle
Top	Spare	2”	flange	
Top	Inlet	1”	flange	
Top	Vent	1.5”	flange	
Top	Breather	2”	flange	

Top, center	Loop return with Sprayball	3”	flange	
Top	Level transmitter	By Vendor	flange	[top or bottom depending on level transmitter]
Bottom center	Outlet	XXX”	flange	Provide Vortex Breaker

M. Quality Control :

1. Vendor shall have active quality control program.
2. Tank fabrication and all welds shall be inspected, and inspection shall be documented.
3. Testing shall conform to ASTM D-1998.
4. Tank shall be kept clean during and after fabrication consistent with use for high purity service.

2.13 STORAGE TANK PRESSURE/VACUUM RELIEF

A. Vendor shall provide pressure and vacuum relief to protect tank in the event of blockage of vent filter or overfilling due to failure of level controls.

B. Vendor shall ensure that relieving device does not open during normal operation, but opens adequately under excessive vacuum or pressure to protect tank.

C. Breather Valve

1. Description: Breather vent valve with pressure and vacuum relief
2. Acceptable Manufacturers: Protectoseal or approved equal
3. Design Conditions
   a. Pressure relief setting 12” water column
   b. Vacuum relief setting 12” water column
   c. Size: 2”

4. Mechanical
   a. Material: **[Aluminum][Stainless steel]**; Teflon seat
   b. Connections
      1). Tank: 2” Flange, 150# ANSI
      2). Pressure out 2” Flange, 150# ANSI
      3). Vacuum in:open

2.14 STORAGE TANK SPRAY BALL ASSEMBLY

A. Description: Static spray ball**[s]** with connecting piping

B. Sprayball

1. Acceptable Manufacturers: Sanimatic or approved equal
2. Design Conditions: **Per manufacturers specifications**
3. Material: .....316L stainless steel with 25 Ra finish; Teflon
4. Connection: Slip joint with stainless steel pin
5. Pattern: .....180 degrees upward; uniform coverage**.**
6. Features:.....Self draining

C. Piping

1. Specification: Piping as per referenced section.
2. Configuration: Piping to suspend ball**[s]** at location**[s]** that provide complete and uniform coverage spray to top of tank. Piping to attach to tank flange. Connection to return line shall conform to mechanical connections as per piping Section.

2.15 STORAGE TANK VENT FILTER

A. Description: Cartridge filter housing and hydrophobic sterile filter element for vent filtration.

B. Acceptable Manufacturers: Pall, Millipore, Sartorius, or approved equal

C. Design Conditions

1. Rating: 0.2 micron
2. Pressure Drop: 0.2 psid maximum at **[**8 scfm**] [XXX]**

D. Filter Housing:

1. Material: Polypropylene
2. Pressure Rating: 50 psig minimum
3. Gasket Material: Silicone
4. Configuration: In line

E. Filter Element:

1. Quantity: per Vendor
2. Grade: Pharmaceutical, 0.2 micron absolute, hydrophobic
3. Material: PVDF/Polypropylene

2.16 DISTRIBUTION PUMPS

A. Vertical, multistage, stainless steel centrifugal, Grundfos CRN or approved equal

B. Grundfos model CRN-5

C. Design rating: 40 gpm at 140 ft

D. Surfaces in contact with water shall be 316 stainless steel.

E. Nozzles shall be 150# ANSI flanges.

F. Seal shall be a single mechanical seal with a carbon rotating face and a tungsten carbide stationary seat.

G. Motor shall be TEFC, 460 V, 3 phase, VFD compatible

2.17 INSTRUMENTATION

A. General

1). Instrumentation shall be provided to enable reliable, safe, and efficient operation of the system, and to meet the functional requirements of this specification.
2. Instrumentation shown on the drawings identified in Part 1.1 and in this specification shall be provided.
3. Instruments shall be appropriate for water quality level.

a. Instrument in contract with water downstream of the RO unit shall be of sanitary design. Pressure sensors shall have diaphragm seals.

4. Vendor shall ensure instruments are properly calibrated.

B. Production System

1. Instruments integral to production system shall provide the required functionality with a high level of reliability.
2. Hardness monitor shall be Hach SP510 or approved equal**.**

C. Distribution system:

1. Resistivity and temperature transmitters shall be Thornton or approved equal.
   a. Vendor shall provide calibration certification of installed unit.
   b. Sensors for conductivity/resistivity shall be installed in run of a horizontal tee with flow exiting the upward branch.

2. Flow meters shall be sanitary turbine meters, 316 stainless steel, 3A rating; Flow Technology, Inc., Thornton, Hoffer Flow Controls, or approved equal;
   a. Straight pipe upstream and downstream of flow meters as specified by manufacturer

3. Tank level transmitter shall provide continuous measurement of water level.
4. Diaphragm seals shall be provided for all gauges and pressure transmitters on piping and equipment in distribution system. Alternatively, pressure gauges with 3A rating can be used.
5. Thermowells shall be 316 stainless steel, 3A rated.
6. Pressure regulators and backpressure regulators shall be installed with at least 10 pipe diameters of straight pipe upstream and downstream of regulator.
7. Self contained backpressure regulator and gauge shall be provided on the end of the return line of the distribution loop.
   a). Specification as per referenced piping section
   b). Adjustable pressure range 35 to 65 psig.

8. Pressure Gauges shall have minimum 3.5” face.

D. Flow meter for recirculation line

a.	Description:	Rotameter
b.	Manufacturer:	Blue-White Series F-460 or approved equal
c.	Range:	1 to 40 gpm water
d.	Material:	
1).	End Fittings:	316 SS
2).	Float and Rod:	316 SS
3).	Metering Tube:	Acrylic
4).	O-Rings:	Viton

2.18 CONTROL SYSTEM

A. General

1. Controls shall be provided to enable reliable, safe, and efficient operation of the system, and to meet the functional requirements of this specification.
2. Vendor shall provide:
   a. A dedicated control system to monitor and control the entire system

b. Design of the control system, hardware, and software.
c. Controls and instrumentation required to ensure proper operation of the equipment and to consistently and reliably produce and maintain the required water quality.
d. Programming to accomplish the required functions. Programming shall be systematically tested, including challenge testing, and testing shall be documented.
e. A functional Specification that completely describes the operation of the system and specifies the acceptable ranges for operating parameters.

3. This specification is written for systems that have a dedicated PLC on RO unit; and would require second PLC for distribution system. Optionally, a single PLC that would control entire system would be acceptable and preferable.

B. Hardware

1. PLC shall be an Allen Bradley MicroLogix or CompactLogix.
2. HMI shall be Allen Bradley Panelview 550 Plus
3. System shall have 20% spare processing capacity and space for cards that would provide an additional 20% I/O.

C. Functionality

1. System shall automatically:
   a. Operate the production system
   b. Start and stop of flow from the production system into the storage tank based on tank level.
   c. Stop the flow from the production system into the storage tank if the resistivity falls below the acceptable value or if key production operating parameters are out of range.
   d. Adjust the speed of distribution pump to maintain constant flow rate at end of loop.
      1). The loop has one primary pump and one standby pump, with manual switchover**.**
   e. Stop the distribution pump[s] if tank is below Low Low level.
   f. Turn UV light on and off

2. System shall continuously monitor and provide alarms for:
   a. Chlorine concentration in supply to RO
   b. Tank levels
   c. Discrete alarm signals from RO, UV lights, and other equipment to ensure safe and proper operation of those units.
   d. Resistivity of water from the production system that is supplied to storage tank
   e. Distribution loop:
      1). Resistivity, on supply line
      2). Resistivity, flow, temperature on return
   f. Distribution pump running
   g. Faults from distribution pump VFD.
   h. Status of distribution pump.

3. Control system shall provide:
   a. One discrete general fault output for connection to the BAS system corresponding to any alarm condition.
   b. An Alarm List.
   c. Capability of assigning multiple levels of alarms for all analog monitored parameters: low low, low, high, high high.

d. Capability of providing a time delay for each alarm.
e. Password protected, multilevel security to prevent change of primary operating parameters by unauthorized personnel.

4. Alarms
   a. Vendor shall specify appropriate operating ranges and alarm setpoints for the production system.
   b. Alarm for the distribution system and preliminary setpoints shall be as follows:
      1). Storage Tank Level
         a). High High - Approx. 95% capacity: Provide Alarm.
         b). Full - Approx. 90% capacity
         c). Add - Approx. 75% capacity
         d). Low Low alarm - Approx. 50% capacity: Provide Advisory message. This level indicates that makeup is inadequate.
         e). Low - Approx. 5% capacity: Shut down distribution pumps and provide alarm. Pumps shall not start under Low Low level conditions.
      2). Alarms shall only be active when pump has been in Automatic Mode for at least 1 minute.

5. Operator Interface (Panelview) shall:
   a. Provide graphical displays that show process in flow diagram format
      1). summary screen**[s]**
      2). Several individual screens, dividing the system into logical parts, sufficient to clearly and logically display content.
   b. Display:
      1). all monitored parameters on the graphics
      2). operation status of equipment
      3). Active Alarms
      4). Alarm History

D. Panels

1. NEMA 12 panel(s) shall be provided to contain controls, solenoids, operator interface, motor starters, step down transformers, and other devices required for system.
2. Panels shall be designed and listed in accordance with UL 508A.
3. Transmitters to be mounted in panels where feasible.
4. Power for transmitters and instrumentation shall be provided from panel.
5. Local horn and beacon for alarm conditions shall be provided. Provide alarm silence button.
6. Panels shall provide 20% minimum spare capacity of space, PLC chassis space, wireway space, and terminal blocks to allow for future expansion by adding I/O cards and associated cabling.

2.19 ELECTRICAL POWER

A. Vendor shall provide all panels, devices, wiring, local disconnects, VFDs and motor controls for the system.

1. A separate low voltage panel shall be provided for the PLC and HMI.
2. Panels shall be designed and listed in accordance with UL 508A.
3. An E-stop shall be provided.
4. Electrical components and installation shall conform to the NEC.

5. Equipment and installation shall conform to the latest requirements or state and local authorities having jurisdiction.
6. UL labeled equipment shall be provided to the full extent that UL labels are applicable.
7. Wiring shall comply with methods approved in NFPA 79.

B. Motors

1. NEMA Premier efficiency as per NEMA MG. 1-2003.
2. Service factor of 1.2 Shall not operate in service factor
3. TEFC
4. Conform to requirements of NEMA, IEEE, NSI, and NEC standards and shall be listed by UL for service specified.

C. Drops will be provided, under the electrical contractor's scope of work, at the following locations:

1. Individual 110 VAC/1 ph/60 Hz drops to equipment prior to the reverse osmosis unit.
2. One 480 VAC/3 ph/60 Hz drop to panel on the reverse osmosis unit.
3. One drop 480 VAC/3 ph/60 Hz to a distribution system equipment panel.
4. Vendor shall provide for distribution of power from these panels to accommodate all of Vendor's needs.
   a. Vendor will be responsible for transforming power as required.
   b. Vendor shall provide detailed instructions to Contractor covering any field wiring between Vendor equipment.
   c. Vendor shall provide local disconnects.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. Coordinate delivery of tank and skids with building construction to ensure that tank can be moved into building and set in place.

B. Inspect delivered equipment and components for evidence of damage or contamination

C. Rig, handle, store, set, and anchor equipment as per Vendor's recommendations and in manner that prevents impact damage and excessive stress.

D. Maintain a high level of cleanliness during handling and installation.

1. Prior to starting work, identify areas that will be used for storage and fabrication, and take measures to prevent contamination from adjoining areas.
2. Keep openings on assemblies sealed during fabrication to prevent contamination prior to final installation.

E. Provide housekeeping pads as indicated on the drawings identified in Part 1.1.

1. Determine final size of pads based on approved Vendor submittal drawings.

F. Install equipment level and plumb.

G. Interconnect Vendor equipment as required

1. Install HPW piping in compliance with specification in "Related Work"
2. Connect utilities.

H. Ensure that the system is ready for safe startup.

I. Provide tagging for equipment, piping, and valves.

J. Coordinate startup, balancing, testing and turnover of system with Owner and Vendor.

1. Contractor shall be responsible for maintaining system in good working condition until final turn-over to Owner. Contractor may choose to actively operate system or place system in safe, non-operational state if significant time period is anticipated prior to Owner turn-over.
   a. Contractor shall monitor system to assure all parameters are within specified ranges if system remains in operation. Contractor shall perform routine maintenance to keep system in proper operating condition.
   b. Contractor shall be responsible for protecting system from damage or degradation if system is to be placed in non-operational state. Procedures and protective measures shall comply with manufacturer's recommendations for storage. System shall be drained and purged/dried with nitrogen to prevent corrosion. Contractor shall identify utility and other live system connections that should be isolated and locked out. Remove and store internal elements that can degrade if system is not operational. Provide written startup procedure for restoring system to operation.

3.2 VENDOR RESPONSIBILITIES

A. Provide a representative responsible for on-site activities:

1. Verify that system is ready for startup.
   a. Inspect installation, interconnections, utility connections, vents, etc
   b. Load media and filter elements as required.
   c. Conduct pre-startup check-out.

2. Startup and test system.
   a. Verify proper operation in all operating modes.
   b. Adjust operation of equipment and controls to meet operational, water quality, and safety requirements, and update documentation as required.
   c. Test and balance distribution system and achieve stable operation at specified flow and pressure conditions.
   d. Adjust self contained backpressure regulator at end of distribution loop to maintain pressure at its upstream pressure gauge at the design setpoint value.
      1). Verify system flows are as per design values

3. Sanitize system as per procedure.
4. Demonstrate to the Owner or to the Commissioning Agent that system operates in accordance with requirements of this specification and per approved submittal documentation.
   a. Provide procedures that systematically verify that system operates as designed.
      1). Identification of acceptable ranges for all operating parameters.
   b. Draw samples from at least 4 locations on the distribution loop and provide the results of analysis indicating that the water meets the bacteria level requirement.
      1). Arrange for the bacterial analysis to be performed by an independent testing laboratory, using standard methods, compliant with the requirements of the water quality standard in Part 1.5.
   c. Calibrate resistivity and TOC monitors and provide calibration certification.

5. Maintain operational oversight of system until Owner's organization is able to assume responsibility for operation.

6. Provide Turn Over documentation as identified in Part 1.
   a. Documents shall include the final operational setpoints and information.

7. Provide training for Owner
   a. Provide a program that covers overview, operator training, and maintenance training.
   b. Operations training shall include:
      1). Start-up procedure
      2). Shutdown procedure
      3). Emergency operations
      4). Safety procedures and hazards
      5). Alarm conditions and actions
      6). Parameter adjustments
      7). Security

END OF SECTION 226720.13

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SECTION 230000 - GENERAL HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 23. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.2 RELATED WORK

A. Section 20 0000 - General Mechanical Requirements

B. Section 20 0513 - Motors

C. Section 20 0514 - Variable Frequency Drives

D. Section 20 0520 - Excavation and Backfill

E. Section 20 0529 - Piping and Equipment Supporting Devices

F. Section 20 0553 - Mechanical Systems Identification

G. Section 20 0573 - Mechanical Systems Firestopping

H. Section 20 0700 - Mechanical Systems Insulation

PART 2 - PRODUCTS

2.1 NOT APPLICABLE TO THIS SECTION.

PART 3 - EXECUTION

3.1 NOT APPLICABLE TO THIS SECTION.

END OF SECTION 230000

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SECTION 230550 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 23 3314 - Ductwork Specialties (Duct Flexible Connections)

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 DESIGN CRITERIA

A. Isolate all motor driven mechanical equipment, unless otherwise noted, from building structure, and from systems that they serve, to prevent equipment vibrations from being transmitted to structure. Unless specifically indicated, follow the latest edition of ASHRAE Application Handbook - Sound and Vibration Control, or manufacturer's recommendations for isolator selection whichever is more stringent.

B. Select and locate isolators to produce uniform loading and deflection. Use minimum of 4 isolators to support each piece of equipment.

C. Select vibration isolation devices based on the lowest operating speed of equipment.

D. Vibration Criteria:

1. All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following schedules.
2. Vertical vibration of rotating equipment shall not be greater than levels indicated. Vibration shall be measured on equipment. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

Equipment Speed rpm	Maximum Allowable Vibration Displacement Peak-to-Peak (mil)
100 to 200	10
200 to 300	6
300 to 600	4
600 to 1000	3
1000 or 2000	2
over 2000	1

E. Following field installation, each fan and pump over 25 hp shall be balanced in accordance with the following maximum rms velocity levels:

1. Fans: 0.15 inch/sec
2. Pumps:

0.16 inch/sec	for 30 hp and smaller
0.18 inch/sec	for 40 through 60 hp
0.20 inch/sec	for 75 through 100 hp
0.22 inch/sec	for 125 hp and larger

Allowable field pump vibration values above are based on HI 9.6-2000, Figure 9.6.4.12.

F. Final in-field balance shall be measured with each fan over 25 hp installed on springs specified for unit. Fans shall be loaded with design static pressure. Measurement shall be carried out in vertical, horizontal and axis planes at impeller shaft bearing location.

1.4 SUBMITTALS

A. Submit Shop Drawings including, but not limited to, the following:

1. Manufacturer's name
2. Isolator type and model number
3. Materials of construction and finish
4. Dimensional data
5. Load ratings (lbs)
6. Isolator free and operating heights
7. Static deflections
8. Isolation efficiency based on lowest operating speed
9. All other appropriate data

B. Provide seismic restraints for all vibration-isolated equipment. Restraints shall not be in contact with the equipment during its normal operation, but shall be capable of withstanding loads imposed by seismic acceleration of the equipment in any direction during seismic event.

1.5 SUPERVISION, INSPECTION AND CERTIFICATION

A. Vibration isolation manufacturer or qualified representative shall provide supervision to assure correct installation and adjustment of isolators. Upon completion of installation and after system is put into operation, manufacturer or manufacturer's representative, shall make final inspection, adjustment, and submit report to Engineer in writing, certifying correctness of installation and compliance with Specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials used shall retain their isolation characteristics for life of equipment served. Elastomeric materials shall comply with ASTM D2240 and shall be oil-resistant industrial grade neoprene.

B. Isolators shall be treated to resist corrosion.

C. Isolation devices subject to weather shall have either hot-dip or cold-dip galvanized, cadmium plated, or neoprene coated finish after fabrication and be furnished with limit stops to resist wind.

D. Vibration isolator springs shall have minimum additional travel to solid equal to 50% of rated deflection.

E. Ratio of lateral to vertical stiffness of vibration isolators shall not be less than 0.8 or greater than 2.0.

F. Coordinate selection of devices with isolator and equipment manufacturer.

2.2 MANUFACTURERS

A. Mason Industries, Amber/Booth Co., Aeroflex-VMC-Korfund. Vibration Eliminator, Vibro-Acoustics, or Kinetics equal to manufacturer's model listed, except flexible pipe connections.

B. Mason, Metraflex, Proco, Twin City Hose, Engineered Flexible Products (EFP) or Flex-Weld/Keflex for flexible pipe connections.

2.3 TYPE 1 MOUNTS (NEOPRENE PAD)

A. Mason Type Super W, neoprene waffle pads, 50 durometer. Select number and size of pads as required to accept equipment operating weight evenly.

2.4 TYPE 2 MOUNTS (NEOPRENE PAD)

A. Mason Type ND or rails Type RND, double deflection neoprene mounts with cast-in metal inserts for bolting to equipment.

B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above mountings to compensate for overhang.

2.5 TYPE 3 MOUNTS (UNHOUSED SPRING WITH NEOPRENE)

A. Mason Type SLF, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between baseplate and support.

B. Mountings shall have leveling bolts rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load.

2.6 TYPE 4 MOUNTS (RESTRAINED SPRING WITH NEOPRENE)

A. Mason Type SLR, combination spring and neoprene with rib molded base similar to Type 3 above, but shall have housing that includes vertical limit stops to prevent spring extension when weight is removed.

B. Installed and operating heights shall be the same. Maintain minimum clearance of 1/2" around restraining bolts and between housing and spring so as not to interfere with spring action. Limit stops shall be out of contact during normal operations. Use height saving brackets.

2.7 TYPE S BASES (STEEL BASE)

A. Mason Type WF, structural steel bases, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. Perimeter members shall be beams with minimum depth equal to 1/10 of longest base span between isolators, but not less than 4". Beam depth need not exceed 14" provided that deflection and

misalignment is kept within acceptable limits as determined by manufacturer. Employ height saving brackets in all mounting locations to provide base clearance of at least 1" above floor or housekeeping pad.

2.8 TYPE I BASES (INERTIA BASE)

A. Mason Type K, or BMK rectangular or T shaped structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. Base depth need not exceed 12" unless specifically recommended by base manufacturer for mass, rigidity or component alignment. Base depth shall be a minimum of 1/10 of longest base span between isolators, but not less than 6". Forms shall include concrete reinforcement bars welded in place running both ways. Furnish forms with drilled steel members with sleeves welded below holes to receive equipment anchor bolts where anchor bolts fall in concrete locations. Employ height saving brackets in all mounting locations to maintain base clearance of at least 1" above floor or housekeeping pad.

2.9 TYPE 5 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30N, vibration hangers with steel spring and neoprene element in series. Neoprene element shall be molded with rod isolation bushing that passes through hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30° arc before contacting hole and short circuiting spring.

B. Mason Type DNHS may be used where load rating and specified deflection cannot be accommodated by Type 30N.

2.10 TYPE 6 HANGERS (PRECOMPRESSED SPRING HANGER WITH NEOPRENE)

A. Mason Type PC30N, vibration hangers similar to Type 5, but precompressed to rated deflection so as to keep piping or equipment at fixed elevation during installation. Design hangers with release mechanism to free spring after installation complete and hanger is subjected to its full load.

2.11 TYPE 7 HANGERS (SPRING HANGER WITH DEFLECTION INDICATOR)

A. Mason Type HES, steel spring in steel housing including deflection indicator scale. Hangers shall be preset at factory for required load. Select hangers so that actual loads do not exceed rated capacities (lbs).

B. Submittals shall include isolator rated deflection, required deflection and supporting calculation. Calculations shall be made by registered mechanical or civil engineer demonstrating structural adequacy of hanger and that hanger connections to building and pipe are adequate for live and dead loads encountered.

2.12 TYPE 8 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30, W30, or PC30 steel spring located in neoprene cup manufactured with grommet to prevent short-circuiting of hanger rod. Neoprene cup to contain steel washer designed to properly distribute load on neoprene and prevent its extrusion. Spring diameters and hanger box lower hole size to be large enough to permit hanger rod to swing through 30° arc before contacting hole and short-circuiting spring. Provide hangers with rod attachments or eyebolts on spring end.

2.13 TYPE T THRUST RESTRAINTS

A. Mason Type WB, horizontal thrust restraint consisting of spring element in series with neoprene pad as described for Type 3 mounts with the same deflection as specified for mountings or hangers. Spring element shall be contained within steel frame and designed so it can be preset for thrust at factory and adjusted in field for maximum of 1/4" movement at start and stop. Furnish thrust restraints complete with rods and angle brackets for attachment to both equipment and ductwork or equipment and structure. Attach horizontal restraints at centerline of thrust and symmetrically on either side of unit.

2.14 FLEXIBLE PIPING CONNECTORS

A. Flexible connectors shall be suitable for pressure, temperature and fluid involved, but not less than 215 psig working pressure at 250°F for 14” and smaller and 150 psi working pressure at 250°F for 16” and larger.

B. Flexible connectors shall be straight pipe configuration and shall not be used to replace pipe fittings such as elbows.

C. Where metal braided covered flexible connector is utilized, minimum live length of flexible connector shall be as follows.

Nominal Pipe Diameter (in)	Minimum Live Length (in)
2-1/2” and smaller	12”
3” and 4”	18”
5” and larger	24”

D. Water System:

1. Connection to Rotating Equipment:
   a. Connectors shall consist of Kevlar or Nylon tire cord fabric reinforced with EPDM cover and liner. Solid steel rings or steel wire shall be used within raised face rubber flanged ends to prevent pullout. Furnish connectors with control rods only where recommended by connector manufacturer.
   b. 2" and Smaller: Threaded connections, single sphere design similar to Mason SAFEFLEX SFU.
   c. 2-1/2" and Larger: Floating steel flange connections, two sphere design with ductile iron or plated carbon steel reinforcing rings, similar to Mason SAFEFLEX SFDEJ. Single sphere design similar to Mason SAFEFLEX SFEJ, may be used for 14" and larger.

2. Connection to Non-rotating Equipment Mounted on Vibration Isolators:
   a. Seamless corrugated bronze or stainless steel flexible connector with braided cover for 2" and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 2-1/2" and larger with flanged connections.

E. Refrigerant System:

1. Seamless corrugated bronze flexible connector with bronze wire braided cover and standard copper tube ends for copper piping. Seamless corrugated stainless steel flexible connector with braided cover for steel piping.

F. Compressed Air Systems:

1. Seamless corrugated bronze flexible connector with bronze wire braided cover for copper piping and seamless corrugated stainless steel flexible connector with braided cover for steel piping. Connector ends shall be threaded, soldered, or flanged to match piping system valve ends.

G. Do not provide flexible piping connectors for compressed air piping.

H. Do not provide flexible piping connectors for gas piping.

2.15 PERFORMANCE

A. Select vibration isolation devices to achieve either minimum 95% isolation efficiency or minimum static deflection and mounting requirements listed below, whichever is greater. Minimum static deflections listed below are not nominal but certifiable minimums with actual installed load. Unless otherwise indicated, apply requirements listed for floor mount for roof-mounted equipment.

Type of Equipment	Ground Supported Slab		Floor Span							
			Up to20 ft		20 ft to 30 ft		30 ft to 40 ft		40 ft to 50 ft	
	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)	Type	Min Defl. (in)
Boilers (Fire-tube):	1	0.25	4-S	0.75	4-S		4-S	2.5	4-S	2.5
Pumps:										
Close Coupled										
Thru 7.5 hp	Bolt to pad		3-I	0.75	3-I	0.75	3-I	0.75	3-I	1.5
10 hp and over	Bolt to pad		3-I	0.75	3-I	1. 5	3-I	1.5	3-I	2.5
Flexible Coupled (End suction and double suction/split case)										
Thru 40 hp	Bolt to pad		3-I	0.75	3-I	1. 5	3-I	1. 5	3-I	2.5
50 - 125 hp	Bolt to pad		3-I	0.75	3-I	1. 5	3-I	2.5	3-I	3.5
150 hp and over	Bolt to pad		3-I	1.5	3-I	2.5	3-I	3.5	3-I	3.5
Inline	Support inline pumps by connected pipes if suspended or by pipe stands or support frame from floor as shown. No vibration isolation mounts are required. Provided spring hangers for connected piping as specified in this Section.									
Air-Cooled Condensers:	-	-	4	0.75	4	1.5	4	2.5	4	3.5
Air-Cooled Condensing Units:	-	-	4	0.75	4	1.5	4	2.5	4	3.5

Air Handling Units:										
Suspended										
Thru 5 hp	-	-	5	1.0	5	1.0	5	1.0	5	1.0
7-1/2 hp and over	-	-	5	3.5	5	3.5	5	3.5	5	3.5
Thru 400 rpm										
401 rpm and over	-	-	5	1.0	5	1.5	5	1.5	5	1.5
Floor Mounted										
Thru 5 hp	3	0.75	3	0.75	3	0.75	3	0.75	3	0.75
7-1/2 hp and over	3	0.75	3	3.5	3	3.5	3	3.5	3	3.5
Thru 400 rpm										
7-1/2 to 40 hp	3	0.75	3	0.75	3	1.75	3	1.75	3	1.75
401 rpm and over										
50 hp and larger	3	0.75	3	0.75	3	1.75	3-S	2.5	3-S	2.5
401 rpm and over										
Air Compressors:										
Tank Mounted Horizontal										
Thru 10 hp	3	0.75	3	0.75	3	1.5	3	1.5	3	2.5
15 hp and over	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
Tank Mounted Vertical and Base Mounted										
All sizes	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
Vacuum Pumps:										
Tank Mounted Horizontal										
Thru 10 hp	3	0.75	3	0.75	3	1.5	3	1.5	3	2.5
15 hp and over	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5
Tank Mounted Vertical and Base Mounted										
All Sizes	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5	3-I	2.5

Utility Set Fans:

Suspended	Use Type 5 hangers with deflection from blower minimum deflection guide, but not to exceed 2.5”.
Floor Mounted	Use Type 2 for 0.75” deflection, Type 3 for 1.5” deflection and Type 3-S for over 1.5” deflection with deflection from blower minimum deflection guide, but not to exceed 2.5”.
Roof Mounted	Use Type 4 mount with deflection from blower minimum deflection guide up to 0.75” deflection. Over 0.75” deflection, use Type 4-S mount.

Centrifugal Blowers:

Suspended	Use Type 5-T hangers with deflection from blower minimum deflection guide.
Floor Mounted	
Up to 22” diameter all sizes	Use Type 2 mount with 0.25” deflection for slab on grade, Type 3 mount with 0.75”deflection for floor span up to 30’, and Type 3 mount with1.5” deflection for floor span over 30’.
24” diameter and up	
Thru 40 hp	Use Type 3-S mount with deflection from blower minimum deflection guide. Provide Type T thrust restraint for fans operating at 2” or more static pressure.

50 hp and over	Use Type 3-I mount with deflection from blower minimum deflection guide.
Axial Fans, Plenum Fans, Centrifugal Inline Fans, Cabinet Fans:	
Suspended	Use Type 5 hangers with deflection from blower minimum deflection guide. Use Type 5-T for over 4" static pressure.
Floor Mounted	
Up to 22" diameter all sizes	Use Type 2 mount with 0.25" deflection for slab on grade, Type 3 mount with 0.75"deflection for floor span up to 30 ft, and Type 3-I mount with1.5" deflection for floor span over 30 ft.
24" diameter and up	
Thru 2" WG SP	Use Type 3-S for slab on grade and floor span up to 20 ft, and Type 3-I mount for floor span over 20 ft with deflection from blower minimum deflection guide.
Over 2" WG SP	Use Type 3-I mount with deflection from blower minimum deflection guide.
Fan Coil Units, Heat Pump Units and Fan Powered Boxes	Type 5 with minimum deflection of 0.5" for 600 cfm or less and 0.75" for over 600 cfm.
Piping Connected to Rotating or Recipro-Equipment:	Use flexible piping connections, and Type 6 hangers for distance of 100 pipe diameters or 50 ft away from equipment, whichever is greater. Hangers shall have minimum deflection of 0.75" for pipe sizes 3" and smaller, 1.5" for pipe sizes 4" through 6" and 2.5" for pipe sizes 8" and larger. For piping less than 2" in diameter, neoprene or felt pad inserted between pipe or pipe covering and clamp or hanger may be used in lieu of Type 6 hangers. Where piping is floor-supported, above requirements shall apply, but use Type 3 mounts instead of hangers. Flexible piping connection shall not be used for unit heaters and in-line pumps that are supported by connected pipes. Type 6 hangers with 1" minimum deflection shall be applied within one foot of both sides of in-line pump and for distance of 100 pipe diameters or 50 ft away from first hanger at in-line pump, whichever is greater.
Piping 2.5" and Larger Supported from Underside of Second Floor:	Use Type 5 hangers with 0.75" minimum deflection.
Ductwork in Mechanical Equipment Rooms:	Use Type 8 hangers with 0.75" minimum deflection for ducts with cross sectional area greater than 2.0 sq ft and where air velocity is greater than 2000 fpm for distance 50 ft from fan.
Ductwork Suspended Underneath Second Floor:	Use Type 8 hangers with 0.75" minimum static deflection for ductwork under the following circumstances: Air velocities greater than 2000 fpm and duct cross sectional area greater than or equal to 2.0 sq ft.

BLOWER MINIMUM DEFLECTION GUIDE

When blowers are 60 hp or larger, select deflection requirements for next larger span, but not less than 2-1/2".

	Required Deflection (Inches)				
Fan Speed (rpm)	On Grade	Up to 20 ft Floor Span	20 ft to 30 ft Floor Span	30 ft to 40 ft Floor Span	40 ft to 50 ft Floor Span
Up to 300	2.5	3.5	3.5	3.5	3.5
301-500	1.5	1.5	2.5	2.5	3.5
501 and over	0.75	2.0	2.0	2.5	3.5

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and adjust vibration isolation devices as specified, as shown on drawings and according to manufacturer's recommendations.

1. Adjust isolators after piping system is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
3. Adjust active height of spring isolators.
4. Adjust restraints to permit free movement of equipment within normal mode of operation.
5. Adjust air-spring leveling mechanism.

B. In no case shall installation short circuit isolation devices.

3.2 INERTIA BASES (TYPE I BASES)

A. Provide required concrete for inertia bases. Refer to Section 20 0000 - General Mechanical Requirements for concrete work.

B. Raise inertia bases to final elevation with temporary blocking prior to making piping connections to pumps or ductwork connections to fans. After connections are complete, install vibration isolators in accordance with manufacturer’s installation instructions.

3.3 PACKAGED AIR HANDLING UNITS

A. Install Type T thrust restraints at fan sections when fan section is isolated from remainder of air handling unit.

3.4 FLEXIBLE PIPING CONNECTIONS

A. Provide flexible connections for piping connected to rotating or reciprocating equipment, equipment such as coils mounted on vibration isolators, and as indicated on plans and details.

B. Piping connected to coil which is in assembly where fan is separately isolated by vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.

C. Piping connected to steam heating coils in floor mounted air handling units where coils are supported without vibration isolation shall have flexible piping connections and piping vibration hangers to prevent thermal stress in piping system from damaging the coils.

D. Install flexible connections on equipment side of shut off valves and horizontal and parallel to equipment shafts where applicable.

E. For non-metallic flexible piping connections, 2-1/2" and larger, use flange type recommended by manufacturer. Flanges for mechanical grooved connections are not allowed.

END OF SECTION 230550

SECTION 230594- WATER SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 2118 - Valves (balancing valves)

C. Section 23 2120 - Piping Specialties (flow measure devices)

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for HVAC hydronic systems, such as chillers, pumps, convertors and other processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

1. Final TAB reports shall indicate flow rates for all balancing valves installed.
2. Where an air handler or terminal unit contains more than one coil piped in parallel or series, where each coil has a separate balancing valve, the final TAB report shall indicate the flow rates and pressure drop for each coil.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2015 HVAC Applications Chapter 38, and as detailed herein.

E. Mechanical Contractors who are members of AABC, NEBB or TABB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

F. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer

wells. Mechanical Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at the minimum pressure differential.

G. TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.4 SUBMITTALS

A. General:

1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless otherwise directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
2. Reports shall be assembled using 3-ring hard cover binder with project name and location on cover and side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB, AABC or TABB wherever possible. Provide sortable electronic version as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:

    a. Transmittal letter
    b. Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
    c. Index of numbered tabs listing major systems
    d. Data organized by system in the following order:
        1). Equipment data and measurement summary
        2). Equipment measurement data
        3). Branch main measurement data
        4). Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:

1. Within 30 days of signing contract, Contractor shall submit the following information:

    a. Firm resume
        1). AABC, NEBB or TABB active membership certificate
        2). Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

    b. Supervisor resume
    c. Balance technicians resumes

2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB and ASHRAE publications for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance shall be ± 10% of design flow rates indicated on drawings and schedules.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain the latest Contract Documents including addenda, construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.
2. Narratives: Furnish written narratives of procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow-measuring devices to be used at each pump and terminal device. Include different narratives for constant and variable flow systems. For non-standard water systems, include narratives on how to measure and adjust for different viscosities. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
3. Prebalance Checklist shall include, but not be limited to:

    a. Check for completeness of work
    b. System cleaning
    c. System fill and air venting
    d. Place system into operation
    e. Check expansion tanks and fill pressures
    f. Pump bearings, alignment, starters, vibration isolators, rotation
    g. Setting valves to proper position including shut-off and bypass valves
    h. Set up of controls and control devices

4. Measuring Instrument List: List of measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:

    a. Manufacturer name and model number
    b. Measurement range
    c. Pressure/temperature limits
    d. Date put into service
    e. Date of last calibration
    f. Certificate from calibration firm

5. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument that has not been recalibrated within past year.
6. Samples: Submit copies of TAB forms to be used.
7. Branch circuit and terminal measurements and adjustments: Indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flow rates (including zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial set points on forms.

3.3 SET-UP PHASE

A. Procedure:

1. Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure pump data and flow rates in "as found" condition after initial valve settings are made.

C. Initial Test Report:

1. Submit report to Architect/Engineer and Mechanical Contractor indicating measurements made and including notes of items that are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required prior to submitting Final Report.

B. Final Report:

1. Submit report to Architect/Engineer and to Mechanical Contractor indicating all data, measurements and adjustments as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

1. Architect/Engineer reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance. Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION 230594

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SECTION 230595 - AIR SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 3314 - Ductwork Specialties

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for air systems, such as air handling units, return fans, exhaust fans, air terminal devices, diffusers, grilles and other air moving processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes TAB of existing air systems as defined by drawings, schedules, or specified in this Section.

E. All existing air systems within scope of demolition/renovation areas shall be rebalanced as necessary to provide new air flows as indicated on drawings. This shall include measurements of existing system air flows prior to demolition and confirmation that air flows to all spaces served by systems being modified are equal to air flows that existed prior to work being started.

F. Work is limited to new areas within the construction boundaries and does not include central fan equipment or other areas. Make attempts to balance flows to values indicated. If flow is low, attempt to proportional balance flows to the same percentage below design.

G. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing, Adjusting and Balancing Bureau (TABB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2015 HVAC Application Chapter 38, and as detailed herein.

H. Mechanical Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB

Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor to submit for approval.

I. Owner will separately contract with an independent TAB Contractor to perform all testing, adjusting and balancing of air systems required for this project. Work related to testing adjusting and balancing that must be performed by Mechanical Contractor is specified in other sections of these specifications.

J. TAB Contractor shall perform ductwork leakage tests. Refer to Section 23 3114 - Ductwork. Test equipment will be provided by Mechanical Contractor.

K. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheaves, motor sheaves and/or drive belts.

L. TAB work shall not proceed until assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.4 SUBMITTALS

A. General:

1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless more directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
2. Reports shall be assembled using 3-ring hard cover binder with Project Name and location on cover and side panel. All information sheets shall be 8-1/2" x 11" white bond paper. Use preprinted forms of NEBB, AABC or TABB wherever possible. Provide sortable electronic version as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:
   a. Transmittal letter
   b. Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:
      1). Equipment data and measurement summary
      2). Equipment measurement data
      3). Branch main measurement data
      4). Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:

1. Within 30 days of signing contract, Contractor shall submit the following information:
   a. Firm resume
      1). AABC or NEBB active membership certificate
      2). Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional
   b. Supervisor resume
   c. Balance technician(s) resume

2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

F. LEED Submittal:

1. Air Balance Report for LEED IEQ Prerequisite 1: Documentation of work performed for ASHRAE 62.1-2007, Section 7.2.2, “Air Balancing”.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB, ASHRAE, and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publications for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB, AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

2.2 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to CPW Series by Mocap. Plug material shall be low-density polyethylene.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance is plus or minus 10% of the design flow rates as indicated on drawings and/or as scheduled.

C. For spaces where supply airflow rates and exhaust airflow rates are used to maintain pressure relationships, such as lab spaces, operating rooms, cath labs, ICU rooms, isolation rooms, clean rooms, dirty rooms and animal rooms, maximum acceptable supply air offset shall be 0 to +10% of design flow rate. Associated exhaust air (or return air) flow rate shall be balanced to provide indicated airflow differential between supply air and exhaust air (or return air) after supply air system has been balanced.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.
   a. Samples: Provide copies of all forms to be used.
   b. General narratives: Furnish written narratives of all procedures used. Include separate narratives for each fan and air handling system. Identify flow-measuring devices to be used at each fan, air terminal device, and air outlet. Narrative shall include statement that every air outlet shall be measured and adjusted. Provide different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
   c. Air system narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes including economizer mode using 100% outside air where applicable. Differentiate between constant and variable flow systems.
   d. Non-standard air system narratives: Include narratives on how to measure and adjust for different air densities for systems with static pressures greater than 8" WG or temperatures greater than 140°F.

e. Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.
f. Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, and design velocities.
g. Pressure relationship test narrative: Narratives shall describe how to obtain and measure pressure relationships between spaces as per schedule or as listed below.
   1). Laboratories
h. Fume Hood Certification: Narrative shall include procedures as described in Scientific Equipment and Furniture Association (SEFA) Standard SEFA 1-2006. Each hood shall be labeled with:
   1). Test date
   2). Name of tester
   3). Sash position at 100 fpm and 125 fpm
   4). Hood Classification
i. Refer to fume hood specification for sash type of each hood, design exhaust rate and sash design opening size. Design airflows are based on design operating sash opening and 100 fpm face velocity at the sash opening. Hoods handling isotopes, perchloric acids, and/or carcinogens shall have minimum face velocity of 125 fpm.

2. Pre-balance Checklist - to include, but not limited to:
   a. Check for completeness of work
   b. System cleaning if required
   c. Check fire, smoke and balancing damper positions
   d. Place system into normal operation without economizers.
   e. Install test openings where required.
   f. Indicate type of test holes to be used and installation procedure.
   g. Note condition of filters.
   h. Provide temporary blankoffs to simulate design pressure drops of filters.
   i. Chisel holes and duct tape are not allowed.
   j. Wet cooling coils
   k. Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation
   l. Drive belt tension and alignment
   m. Setting of automatic dampers to proper position including shutoff and bypass dampers
   n. For hoods and ovens indicate temperature and humidity. Correct for density changes.
   o. Set up of controls and control devices

3. Measuring Instrument List - list what measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
   a. Manufacturer name and model number
   b. Measurement range
   c. Pressure/temperature limits
   d. Date put into service
   e. Date of last calibration
   f. Include certificate from calibration firm

4. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.

3.3 SET-UP PHASE

A. Procedure:

1. Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure fan data and flows in "as found" condition after initial damper settings are made.

C. Initial Test Report:

1. Submit report to Architect/Engineer and Mechanical Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

1. Submit report to Architect/Engineer and Mechanical Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

1. Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. TAB Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION 230595

SECTION 230901 - CONTROL SYSTEMS INTEGRATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

B. Section 23 0550 - Vibration Isolation

C. Section 23 0902 - Control Valves And Dampers

D. Section 23 0903 - Control Instrumentation

E. Section 23 0923 - Direct Digital Controllers and Networks

F. Section 23 0924 - Graphical User Interface Integration

G. Section 23 2118 - Valves

H. Section 23 3600 - Air Terminal Devices

I. Section 23 3614 - Laboratory Temperature and Airflow Control System

J. Section 26 0000 - General Electrical Requirements

K. Section 26 0533 - Raceway and Fittings

L. Section 26 0519 - Conductors and Cables

M. Control Sequences: Refer to Drawings

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. ASHRAE FUNDAMENTALS IP - (2013) Fundamentals Handbook, I-P Edition

C. ASHRAE 135 - (2012) BACnet - A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved)

1.3 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

1. Actuator: Control device to provide motion of valve or damper in response to control signal.
2. AI: Analog Input
3. AO: Analog Output
4. Analog: Continuously variable state over stated range of values
5. Auto-Tune: Software routine used to adjust tuning parameters based on historical data.
6. BAS: Building Automation System
7. BMS Building Management System
8. DDC: Direct Digital Control
9. DDCP: Direct Digital Control Panel
10. Discrete: Binary or digital state
11. DI: Discrete Input (Sometimes referred to as Binary Input BI)
12. DO: Discrete Output (Sometimes referred to as Binary Output BO)
13. EMCS: Energy Management and Control System (Typically interchangeable with BAS or BMS)
14. E/P: Voltage to pneumatic transducer (Often solenoid valve is referred to as an E/P transducer)
15. FA Field Adjustable
16. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
17. FLP Fail Last Position
18. FMS: Facility Management System linking two or more BAS
19. FO: Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
20. I/P: Current to pneumatic transducer
21. Instrument: Device used for sensing input parameters or used for actuation.
22. Modulating: Movement of control device through an entire range of values proportional to an infinitely variable input value.
23. Motorized: Control device with actuator
24. NC: Normally Closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
25. NO: Normally Open position of switch after control signal is removed or normally open position of manually operated valves or dampers.
26. Node: DDCP, operator workstation, or other control device connected to communications network.
27. Operator: Same as actuator for motorized devices. Also refers to an individual who physically "operates" facility.
28. PC: Personal Computer
29. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each share its database values with other devices connected to network.
30. P: Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
31. PI: Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (reset control).
32. PID: Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).
33. Point: Analog or discrete instrument with addressable database value.
34. Self-Tune: Same as Auto-Tune

35. Solenoid: Electric two-position actuator. (See E/P.)
36. TCC: Temperature Control Contractor (Same as Control Contractor)
37. TCP: Temperature Control Panel

1.4 ACCEPTABLE CONTROL CONTRACTORS

A. Control Contractor shall have full service office within 100 miles of project site. Full service office is defined as being home office of applications engineers, supervisors, and field technicians, having complete parts inventory, and having required test and diagnostic equipment. Control Contractors shall be factory authorized agent or dealer of controllers and control hardware as manufactured by:

1. Johnson Controls, Inc.
2. Honeywell, Inc.
3. Siemens Building Technologies
4. Schneider Electric
5. Trane Company
6. Alerton Technology
7. Automated Logic Corporation

B. Bids will be accepted only from prequalified Control Contractor per "Instruction to Bidders".

1.5 SYSTEMS DESCRIPTION

A. Control system shall be Direct Digital Control (DDC).

B. Space thermostat controls not specified to be DDC shall be pneumatic.

C. Damper and valve actuators shall be pneumatic type, unless otherwise noted.

D. Damper and valve actuators shall be electronic type, unless otherwise noted.

E. The existing campus Building Automation System is Johnson Controls (JCI) system.

F. New BAS shall seamlessly integrate with existing site JCI web server operator interface. Existing web server shall be able to access and read all input, output and calculated points and issue commands to all output points in new BAS by means of a standard web browser. Contractor shall provide necessary hardware and software components to accomplish this interface.

G. Provide modular designed stand-alone controllers capable of future BAS architecture with peer-to-peer and/or low/medium speed communication networks. Upgrade to full BAS architecture shall not require removal of existing controllers, sensors, actuators, etc.

H. BAS network architecture shall be based on an Open implementation of BACnet using ASHRAE 135-2012 exclusively as the communications protocol for communication between DDC Hardware devices, including BAS Web Server, to allow multi-vendor interoperability.

I. Provide BAS architecture consisting of communication network, operator workstations, web servers and modular designed controllers with all points addressable and modifiable from operator workstations or from master controller using laptop computer. BAS shall be fully

expandable with addition of hardware and/or software. Expansion shall not require removal of existing controllers, sensors, actuators, or communication networks.

J. System shall support operator workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.

K. Operator workstations connected to building Ethernet network shall be able to access BAS information as determined by Graphical User Interface (GUI) software through standard web browsing software (Internet Explorer, Mozilla Firefox, Opera, or Google Chrome). GUI software shall allow transparent access to each building component/system for control and/or monitoring.

L. System intelligence shall be such that operator workstation(s) can be used for programming controls, performing analysis on filed data, generating maintenance and operation reports and providing permanent storage for programs and data.

M. Workstation PCs and printers will be furnished by Owner. Provide hardware interface card to communicate with BAS Network and required software for each workstation, as defined in this Section, to make each PC full function workstation.

N. Safety devices shall function in both auto and hand modes on starter, and on VFD in auto, hand or bypass modes.

1. Dampers interlocked with fans shall operate in both auto and hand modes to prevent dead-head of fans.
2. Valves interlocked with pumps shall operate in both auto and hand modes of operation to prevent dead-head of pump.
3. All safeties shall be hardwired through starter/VFD safety circuit to prevent unsafe operation when in either auto or hand modes.

1.6 SCOPE OF WORK

A. Provide all labor and materials for complete fully functioning control systems in accordance with Contract Documents included in this Section plus:

1. Section 23 0902 - Control Valves and Dampers
2. Section 23 0903 - Control Instrumentation
3. Section 23 0923 - Direct Digital Controllers and Networks
4. Section 23 0924 - Graphical User Interface Integration

B. Engineering services shall be performed by Factory Trained Engineers. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's representative. Engineer reserves right to exclude Project Managers, Engineers, Field Supervisors, or Technicians whose past experience is not sufficient to meet needs of Project.

C. Control Contractor’s Project Managers, Engineers and Digital System Programmers shall have previously performed in capacity that qualifies them to successfully engineer system of scope and magnitude similar to this Project.

D. Labor shall include, but not be limited to:

1. Engineering services to size unscheduled valves and dampers based on design criteria specified in Section 23 0902 - Control Valves and Dampers, and confirm sizing of scheduled valves and dampers.
2. Engineering services to produce requested submittals and working construction drawings and record drawings as specified here within.
3. Engineering services for required software programming.
4. Engineering services for graphics programming specified.
5. Engineering services for mapping control points from Laboratory Temperature and Airflow Control System (Section 23 3614), if provided for the project.
6. Engineering services for BAS Ethernet network design.
7. Project management services as single point contact to coordinate construction related activities.
8. Field mechanics for installation of control wiring and related control devices.
9. Field technicians to startup, calibrate, adjust, and tune control loops.
10. Field technicians to perform system checkout and testing, and to complete required reports.
11. Field supervisor during controls installation and startup.
12. Field technicians to assist Mechanical Contractor and Testing and Balancing (TAB) Contractor in adjusting controls and determining setpoints related to TAB work.
13. Field representatives and/or classroom instructors to provide Owner training as specified.

E. Control Contractor shall be responsible for complete installation of control devices (except as noted), wiring, and pneumatic terminations at controller locations to accomplish control sequences specified in project manual or on drawings. Control Contractor is required to provide power for air terminal controllers and other field mounted devices that require 24 VAC, 60 Hertz and shall be powered from 120 to 24 VAC transformer panels provided by Control Contractor. Control Contractor shall also be responsible for additional instrumentation described in point schedules found in Contract Documents, which may not be directly related to specified control sequences.

1. Control contractor shall provide unique tag numbers for all devices under this specification and reference those tag numbers in control sequences and control diagrams.
2. If Owner has tagging convention, Control contractor shall utilize it. If no tagging convention exists, Control contractor shall provide one for all devices under this specification.

F. Mechanical Contractor shall provide wells, taps, and other mechanical interfaces required for control equipment mounting into piping systems. Mechanical Contractor shall install in-line mounted devices, such as valves, dampers, flow meters, static pressure probes, etc., furnished by Control Contractor. Control Contractor shall be responsible for installation of other control devices, such as actuators, linkages, sensors, air terminal controllers, flow transducers, remote mounted control devices, control panels, control transformers, etc.

G. Electrical work required as integral part of control work is responsibility of Control Contractor. Control Contractor is responsible for providing final power connections, including conduit, wire, and/or disconnect switches, to control devices from appropriate electrical distribution panels.

1. Electrical Contractor will provide circuit breakers required to provide electrical power to controllers.
2. 120 to 24 VAC transformer panels shall be provided by Control Contractor and mounted adjacent to controller panels or in Electrical Rooms, Telecommunications Rooms and/or (IDF/EIDF) rooms, or as indicated on plans and powered from dedicated electrical circuit.
3. Should any change in number of controllers or addition of other electrical equipment after Contracts are awarded, Control Contractor shall immediately notify Electrical Contractor of

change. Additional costs due to these changes shall be responsibility of Control Contractor.

4. Coordinate with Electrical Contractor for additional power requirements.

H. Provide temporary Ethernet network for communications between Ethernet-based controllers and BAS servers (Web & Data Historian) until building IT network is available for use by BAS. Temporary Ethernet network and all other communications required for BAS shall be installed as required for specified operation of mechanical equipment to allow check out and commissioning of equipment in timely manner.

I. Control Contractor shall be responsible to provide additional BAS data drops (from telecommunication room patch panel to field jacks/patch panels) that are not accounted for in the contract documents. Coordinate final Telecommunications room patch panel connections with network installation Contractor.

J. Control Contractor shall be responsible for maintaining master IP address list for all BAS devices throughout project to be handed over to Owner upon completion.

K. Materials shall be as specified unless approved through procedures for product substitution specified in Division 01. Control Contractor shall provide components not specifically indicated or specified, but necessary to make system function within the intent of specification.

L. If during the installation period any of the factory equipment or material provided in the system is found to be defective in material or workmanship, it shall be replaced or repaired by Contractor at no additional cost to the Owner within 24 hours from the time the problem was reported/discovered.

M. Any part/device or equipment installed as part of this contract found to be malfunctioning or defective during the warranty period shall be replaced by Contractor within 24 hours from the time the problem was reported.

N. Electrical products shall be listed and labeled by UL and comply with NEMA Standards.

O. All controls and wiring used for smoke control/life safety shall be UL 864 UUKL rated.

P. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.

Q. Provide tamper resistant screws and fasteners for equipment located in accessible and/or public areas.

R. Contractor is responsible for integration of the following independent systems into BAS:

1. Electrical Metering:
   a. Electrical Metering provider will provide Modbus TCP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for Electrical Metering. Control contractor and Electrical Metering provider responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, Section 26 2413 Switchboards and Section 26 2713 Electrical Metering for programming and monitoring requirements.

2. Chilled Water and Natural Gas Metering:
   a. Chilled Water and Natural Gas Metering providers will provide termination points for single point communication connections to BAS. Contractor shall supply cabling, conduit, and gateway necessary to make an interface connection from gateway to the metering points of connection. Contractor is responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 23 for meter bidders. Contractor and meter providers responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&IDs, DDC Point Schedules for programming and monitoring requirements.

3. Boilers:
   a. Boiler provider will provide a termination point for a single point communication connection to the BAS. Contractor shall supply cabling, conduit, and gateway necessary to make an interface connection from gateway to Boiler point of connection. Contractor is responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 23 for Boiler bidders. Contractor and Boiler provider responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules and GMP#2 Section 23 5214 Primary Heating Equipment for programming and monitoring requirements.

4. Lighting Control System (LCS):
   a. LCS provider will provide appropriate network termination points for connection to BAS. Contractor shall supply cabling, conduit, and gateway (if necessary) to make an interface connection from BAS to LCS point of connection. Contractor is responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for LCS bidders. Contractor and LCS provider are responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules, and Division 26 for programming and monitoring requirements.

5. Variable Frequency Drives (VFD):
   a. VFD provider will provide a termination point for a single point communication connection to the BAS utilizing BACnet MS/TP protocol. Contractor shall provide cabling and conduit to make an interface connection from the BAS to the VFD. Contractor and VFD provider responsible for translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules, and Section 20 0514 Variable Frequency Drive (VFD) System for programming and monitoring requirements.

6. Computer Room Air Conditioning Units (CRAC).
   a. CRAC provider will supply a termination point for a single point connection to BAS. Control contractor shall supply cabling, conduit, and gateway necessary to make an interface connection from the gateway to CRAC point of connection. Control contractor responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 23 for CRAC bidders. Control contractor and CRAC provider responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to Section 23 8119 Self-

Contained Air Conditioning Units and DDC Point Schedules for programming and monitoring requirements.

1.7 SUBMITTALS

A. Extended Service Agreement:

1. Control manufacturer shall, upon completion of warranty period, make available to Owner annual service agreement covering all labor and material required to effectively maintain control system after warranty period. Owner reserves the right to accept or reject any such offers and to cancel on-going agreements with 30-day written notice.
2. During extended service period, Contractor shall maintain Operation and Maintenance manuals to reflect all changes made to BAS.

B. Shop Drawings:

1. Submit manufacturer's printed product data sheets for control devices and materials listed in bill of material in Control Contractor's control drawings. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing each device manufacturer and full model number with links to device pages. Organize sheets in order of model number, alphabetically, then numerically. When a manufacturer’s data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Data sheets shall include sufficient technical data to describe instrument parameters required as specified.
2. Submit data concerning type of signal wiring and installation methods including raceway types and grounding methods.
   a. Submit voltage drop calculations for all low voltage DDC circuits. Voltage drop to include number of devices and wiring run lengths, calculated voltage available at each device.

3. Submit control drawings in pdf format with bookmarks provided for each system and table of contents with links to each page. Control drawings shall include, but are not limited to, the following:
   a. Overall system/network architecture drawings: Provide block diagram showing relationship of each controller, control panel, or other network devices relative to each other. Label room location of each device. Number and indicate model number of each device. Indicate network types.
   b. Control Drawings: Including graphic representation of systems with major in-line components to properly locate all control devices. Identify controlled devices with their software designation on drawings, including unique valve and damper tag numbers.
   c. Detailed wiring and piping diagrams showing point-to-point hookup details of transducers, relays, outputs, inputs and subsystem components. Label pneumatic lines and control wires with field ID numbers/colors.
   d. Bill of material identifying actual product model number used for each control device for each schematic control drawing.
      1). Bill of material shall be included on flow diagrams for each system and on panel layouts showing panel components.
   e. Drawings showing proposed locations of sensors and flow meters in ductwork and piping systems.

f. Sequence of operation: Provide written narrative describing each control sequence indicating method of control. Identify sensors, controllers, and actuators used with references to tag number of controlled device. Include set points of each control loop.
g. BACnet Compliance Documentation: The Protocol Implementation Conformance Statement for each component.

4. Control Instrumentation (23 0903) and Direct Digital Controllers and Networks (23 0923) submittals can be submitted as separate submittals from control shop drawings but must be submitted simultaneously with control shop drawings.
5. Submit a sample graphic page for each type of page described in Section 23 0924 - Graphical User Interface Integration.

C. Completion Checklist:

1. Submit with shop drawings, detailed completion checklist including written procedures for adjusting and calibrating each type of instrument and sensor. Engineer reserves the right to request modifications to any procedure, which is incomplete or not adequate to prove system performance.
2. Checklist shall include references to the following additional requirements:
   a. Instruments and sensors shall be calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing.
   b. Each point shall be checked for calibration, connection to correct control loop, and proper setting of limit and alarm values.
   c. Transducers and other output devices shall be properly zeroed and calibrated at both minimum and maximum output. Document settings for discrete instruments and set points for analog instruments shall include minimum and maximum positions for safe operating conditions where applicable (max. pump speed or max. frequency of fan drive, etc.).
   d. Control loops shall be tuned to maintain controlled process variable at set point through seasonal conditions without operator intervention. Provide multiple sets of tuning parameters if necessary. Controller shall automatically use tuning parameters appropriate to existing ambient conditions. Maintain record on completion checklist, of control loops that require tuning at alternate times of year. Instruct technicians to supply default parameters that can approximate stable control until actual load conditions allow proper tuning of control loops.
   e. Performance tests of analog control loops shall be performed by changing set points and verifying that sequences can come into stable control within reasonable time period appropriate for each sequence. Simulate load changes for pressure and flow control loops.
   f. Performance tests of discrete control loops shall be performed by adjusting set point and verifying sequence action.
   g. Alarms, including network failures, shall be tested for each controller and device connected to network. Ensure that alarms are properly acknowledged at operator's workstation.
   h. Schedules for each system/device shall be verified.
   i. Graphics shall be verified for functionality including password protection, floor plan displays, system displays, alarm messaging, historical trends, report generation and HVAC schedules.
   j. BAS Ethernet network testing and benchmarking documentation showing network performance from switch to switch.
   k. Testing of BAS to ensure cyber security. Coordinate testing requirements with Owner.

D. Control Contractor and Mechanical Contractor shall walk proposed static pressure sensor and flow meter locations and mark up drawings for review and approval by Owner and Engineer prior to installation.

1.8 WARRANTY

A. Warranty period shall begin as authorized by the Owner's representative in writing. Authorization will not be given before the following conditions are met:

1. All verified completion checklists provided to Owner.
2. Completion of all punch list items.
3. Conduction of a preliminary training session for personnel. The training shall consist of an orientation session at the job site to familiarize the personnel with the location and type of controlled equipment and controls on the project, a discussion of the control sequences, and a review of the control drawings.
4. Completion and distribution of the as-built control drawings, including correction of all items noted by Owner and Engineer after review of the documents.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. A telephone number where the service supervisor can be reached at all times shall be provided. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

D. This warranty shall apply equally to both hardware and software.

E. Service personnel shall be qualified to accomplish work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

F. Scheduled Inspections:

1. Two inspections shall be performed prior to warranty expiration and all work required shall be performed. Inspections shall be scheduled 6 months after Owner acceptance and one month prior to end of warranty period.
2. These inspections shall include:
   a. Visual checks and operational tests of equipment.
   b. Clean control system equipment including interior and exterior surfaces.
   c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.
   d. Run system software diagnostics and correct diagnosed problems.
   e. Resolve any previous outstanding problems.

f. Install software upgrades, patches and fixes. Contractor to provide verification to facility personnel that all upgrades, patches and fixes to be installed have been tested in accordance with site testing and deployment procedures.

G. Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.

H. Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

I. Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

J. Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

K. During the warranty period, the Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever the Contractor makes a change to the software. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge.

L. At the end of the warranty period, the Contractor shall provide updated copies of the latest versions of all project record documentation as described in Paragraph 1.10, Record Documents. This includes final updated drawings, software documentation, and electronic media backups that include all changes that have been made to the system during the warranty period.

1.9 COORDINATION WITH TAB CONTRACTOR

A. Control Contractor shall allow sufficient time to provide assistance and instruction to TAB Contractor in proper use and setting of control components such as, Operator Workstation computers, static pressure controllers, "K" Factors for VAV boxes, or any other devices that may need set points changes so that TAB work can be performed.

B. Provide required hardware and software related to control system to TAB Contractor to allow testing of systems and continued operation.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements.

B. Operation and Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. Descriptions shall include:

1. Product manuals for the key software tasks.
   a. Operating the system
   b. Administering the system
   c. Engineering the Operator workstation
   d. Application programming
   e. Engineering the network
   f. Setting up the web server
   g. Report creation
   h. Graphics creation
   i. Data backup & Archiving

2. List of recommended maintenance tasks associated with the system, controllers, instruments, operator workstations, data servers, web servers, and web clients.
   a. Define the task.
   b. Recommend a frequency for the task.
   c. Reference the product manual that includes instructions on executing the task.

3. Licenses, guarantees, and warranty documents for equipment and systems.
4. System architecture diagram for components within the building annotated with specific location information.
5. As-built drawing for each control panel
6. As-built wiring design diagram for each control panel
7. As-built system flow diagram for each system
8. Sequence of control for each system
9. Binding map for the building
   a. A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.
   b. Include:
      1). Description of the variable
      2). Sending device
      3). Receiving device

10. Product data sheet for each component
11. Troubleshooting guide
12. Repair parts list
13. Calibration instructions
14. Control Contractor's completion checklist
15. Manufacturer representative's name, address, and phone number

1.11 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements.

B. Submit revised shop drawings indicating changes made during Project.

C. Record drawing submittals shall be inclusive of BAS as installed and commissioned.

D. Update control diagrams to include tuning parameters and set points applicable to systems depicted as of date of system completion. This information shall be incorporated with sequence of operation for each system.

E. Include floor plans showing location of control panels and routing of BAS network cabling.

F. List of all IP addresses assigned on IFMS complete with description of device and associated vendor.

G. BACnet systems and devices:

1. Submit finished device addressing documentation.
2. Submit finished hardcopy of device binding database.

H. Provide passwords, if used, for back-up and restore functions for each controller.

I. Software (as installed and commissioned)

1. All software submittals shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided as part of the BAS.
2. Submit a copy of all software installed on the servers and workstations.
3. Submit all licensing information for all software installed on the servers and workstations.
4. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
5. Submit all licensing information for all of the software used to execute the project.
6. All software revisions shall be as installed at the time of the system acceptance.

J. Firmware Files (as installed and commissioned)

1. All firmware files shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided in the BAS.
2. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
3. Submit control listing of firmware version for all firmware that is permanently burned on a chip at the factory.
4. Submit a copy of all application files that were created during the execution of the project.
5. Submit a copy of all graphic page files created during the execution of the project.
6. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. Owner shall retain all rights to software for this project.

B. Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use on the Owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of Owner. These include but are not limited to:

1. Server and Workstation software
2. Application Programming Tools
3. Configuration Tools
4. Addressing Tools
5. Application Files
6. Configuration Files
7. Graphic Files
8. Report Files
9. Graphic Symbol Libraries
10. All Documentation.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Control wiring shall be in accordance with National Electrical Code and Local Electrical Codes. Final connection points at devices and panels shall be made either at terminal blocks integral to device or at separate terminal blocks mounted inside of control panel enclosures. Use of wire nuts and crimped connections are not allowed for terminating control wiring unless approved by Engineer.

B. Refer to Division 26 for specification requirements for conduits and conductors, except as noted.

C. Terminal Blocks:

1. Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

D. Signal and Power Conductors (24 V and Under):

1. Wires smaller than #18 AWG shall not be used, except for manufacturer supplied instrument specific wire, or where otherwise specified. Use 2-wire stranded twisted/shielded pair 24 VDC for analog and discrete input and 24 VAC/VDC output devices. For 3-lead RTD signal wiring, use #18 AWG stranded, tinned copper twisted/shielded 3-conductor. Provide isolated instrument grounding system as per manufacturer's recommendations.
2. Conductors not concealed in raceway shall have UL Listed plenum rated Teflon insulation.
3. Provide 250 ohm, 5 watt, 0.1% tolerance dropping resistors in 4 - 20 mA circuits as required to generate 1 to 5 volt signals in 24 VDC powered instrument loops.
4. 24 VAC Power Conductors shall be #18 AWG 2 wire twisted pair or larger. Provide Metal Oxide Varistors (MOVs) on 24 VAC/VDC discrete outputs connected to inductive loads to reduce noise levels (i.e., solenoid valves, motor contactors, relays, damper/valve electric actuators, etc.).
5. Stranded twisted/shielded control conductors are required with shields to be terminated within variable frequency Drive enclosures to reduce effects of noise from VFD. Follow VFD manufacturer's installation instructions for wiring control conductors to VFD.

E. Communication Cable:

1. Cable not concealed in raceway shall have UL Listed plenum rated insulation.
2. Floor Level Network Communication Cable (Twisted Pair): Use control system manufacturer's standard communications cable or #22 AWG to #24 AWG twisted, shielded pairs, coaxial cable, or fiber optics for communications between remote controllers/devices
3. Interior LAN Horizontal Communication Cable:
   a. Refer to specification 27 1500 - Communications Horizontal Cabling.
   b. Horizontal copper LAN cable shall meet or exceed all requirements of Category 6 cable as specified in TIA/EIA-568-B.2.
   c. BAS Ethernet network Horizontal copper LAN cable shall be yellow.
   d. Horizontal copper LAN cable shall be terminated in an eight-position modular Jack with color to match system cable.
   e. Horizontal copper LAN cable shall be terminated in a telecommunication room that is on the same floor as the area being served in a 4-pair 100Ω twisted pair modular patch panel with color to match system cable.
   f. Horizontal copper LAN cabling shall not exceed 295 ft.
   g. Provide minimum of 10’ of slack at telecommunication room and 12” of slack at outlet

F. Transient Voltage Surge Suppression Devices:

1. Devices shall be designed for 120 V power conditioning devices for electronic equipment. Devices shall be designed, manufactured, tested, and installed in compliance with ANSI/IEEE C62.41 and C62.45, Federal Information Processing Standards Publication 94 (FIPS PUB 94), NEMA, NFPA 70, 75, and 78, and UL 1449 and 1283. Devices shall be labeled for UL 1449.
2. Clamping voltage for 120 V power systems shall be 400 V.
3. Provide visual indicator of when surge device has been used.

G. Uninterruptible Power Supply

1. Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal
2. Provide UPS for backup power for Operator Workstations, Building Level Controllers, Floor Level Controllers and field panels required for control of emergency/standby powered equipment, UPS shall maintain control upon loss of normal power and until emergency/standby power supply is brought on line.
3. Select UPS for minimum of 5 minutes backup time for load connected. This will allow emergency/standby power sources to come on line and provide backup power to emergency/standby powered equipment.
4. Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.
5. Operating Parameters:
   a. Operating Temperature: 32°F to 104°F
   b. Relative Humidity: 0 to 95% rh, non-condensing
   c. Recharge Time: 8 hours, typical

6. UPS shall have self-diagnostic capability with DO to BAS to allow remote monitoring/alarming of UPS trouble or alarm conditions.

H. Uninterruptible Power Supply (Servers):

1. Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal

2. Provide rack mounted dual/double conversion UPS for backup power for each rack-mounted Server. UPS shall maintain power to Server upon loss of normal power and until emergency power supply is brought on line.
3. Select UPS for minimum of 20 minutes backup time for load connected. This will allow emergency power sources to come on line.
4. UPS shall be provided with power management software and communication cable for interfacing with respective Server.
5. Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.
6. Operating Parameters:
   a. Operating Temperature: 0 to 40°C
   b. Relative Humidity: 0 to 95% rh, non-condensing
   c. Recharge Time: 8 hours, typical

2.2 LOCAL CONTROL PANELS

A. Control panels shall meet the following minimum requirements:

1. Outdoors: Control panels located outdoors shall comply with NEMA 3R or 4X requirements.
2. Mechanical Rooms: Control panels located in mechanical or electrical rooms shall comply with NEMA 4 requirements.
3. Other Locations: Control panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.

B. Local control panels shall be constructed of steel or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color. Construction shall comply with NEMA 1 Standards for interior panels, NEMA 3R for exterior panels.

C. Provide panels of adequate size to accommodate instruments for future expansion of approximately 25% beyond space required for this scope of work.

2.3 NETWORK HARDWARE

A. Ethernet Switches, Routers, and Bridges:

1. Network hardware shall be provided and configured to form a campus-wide Fast Ethernet (a combination of 100BASE-TX and 100BASE-BX, -FX, and –SX or higher).
2. Ethernet devices shall be IEEE Std 802.3 which shall function as the center of a distributed-star architecture and shall be "learning" type with spanning tree algorithms per IEEE Std 802.1D. All devices shall have a non-blocking architecture.
3. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.
4. Network hardware shall be compatible with the copper and fiber optic cabling installed by the Division 27 contractor. Refer to specifications 27 1300 and 27 1500 for media types.
5. Switch located in BAS server rack shall be managed type and shall have a minimum of two fiber optic ports.
6. Switch shall include N.O./N.C. alarm contact for monitoring by BAS.

B. Network Components:

1. Network components (Racks, enclosures, patch panels, etc.) shall comply with respective sections of specification 27 1100 – Communications Equipment Room Fittings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment and wiring in neat and workmanlike manner.

B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, valves, dampers, and other such items furnished by Control Contractor, which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. All BAS associated 120 VAC power wiring (including all input and output power supplies) shall originate from clearly-marked, BAS-dedicated circuit breakers. All input/output transducers shall be powered from the same circuit that supplies power to the associated BAS controller. All BAS equipment shall be fused in accordance with manufacturer's recommendations.

E. 120 VAC power shall not be allowed inside BAS controller panels. All 120 VAC to 24 VAC transformers and 120 VAC to 24 VDC power supplies shall be located in enclosures adjacent to the control panel being served. Terminal unit controls shall be served by consolidated 24 VAC transformer panels.

F. BAS controllers shall be labeled with the source of electrical power including panel number, circuit breaker number, and room number where electric panel is located.

G. Devices containing mercury are not allowed.

H. Coordinate mounting height and location of control devices so that NEC workspace clearances are maintained.

I. During construction, Contractor shall take necessary precautions to ensure all panels, wiring, instrumentation, etc. are kept clean and dry. Upon Project completion, control panels shall be clean of wire nuts, trash, and wire stripping. All excess material is to be turned over to Owner BAS group.

J. BAS floor level network to room/equipment controllers shall be confined to the same floor the respective building level controller is located on.

1. In applications where the floor level network must transition between floors, the transition shall be located in a clearly marked junction box on each floor of appropriate size to accommodate a screw terminal strip. Network cabling shall be labeled to indicate the previous connection prior to entering the junction box with the terminal strip. Terminal strip shall be used as a transition point from one floor to the next. Terminal strip shall be large enough to accommodate transitions to and from the floors below and above if floor transitioning is required.

K. Labels and tags shall be keyed to unique identifiers shown on As-Built drawings. Enclosures and DDC Hardware and controllers shall be labeled. Sensors, valves and actuators shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at location of pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.

3.2 CONTROL WIRING

A. Provide electrical wiring required for complete functional control systems, including power circuit to control panels, both line and low voltage, in accordance with applicable local codes, and latest version of National Electrical Code and NFPA. Refer to Paragraph 1.6.H. for definition of scope of Work.

1. Voltage drops for all low voltage circuits shall be calculated prior to installing low voltage circuits. Voltage drop calculations shall be made available to Engineer on demand.

B. Control panels serving equipment fed by emergency/standby power shall also be served by emergency/standby power. Equipment fed by emergency/standby power is so indicated on mechanical equipment schedules and electrical motor schedules. Control panels shall be powered by local UPS (Uninterruptible Power Supply) to ensure continued control of equipment powered by site standby power sources when primary power source is lost. Devices such as Operator Workstations, Floor Level and Building Level Controllers, Application Specific Controllers and fume hood controls shall be provided with UPS power.

C. Where multiple controllers reside in a single control panel, provide a separate disconnect (or fuse) for each controller.

D. Install control wiring in metal conduit or raceway system. Refer to Division 26 - Electrical for additional requirements.

E. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 0000 – General Electrical Requirements.

F. Color-code each junction box cover plate as to signal type using 1/2" self-adhesive color dot or enamel spray paint. Use green for low voltage signal wiring, blue for pneumatic tubing, and yellow for line voltage wiring used for signal wiring or dedicated power wiring.

G. Tag each wire termination at control panels, junction boxes, and remote control devices with unique wire ID number.

H. Low voltage wiring concealed above accessible ceilings does not require raceway. Cables not in raceway shall be routed along building structure lines using Bridal Rings, J-hooks or other mounting methods as approved by Engineer. Use of wire-ties for attaching cabling to duct brackets, piping or structure is not acceptable. Diagonal routing is not allowed. Label each cable not in raceway with unique wire ID number every 50 ft.

I. Terminate low voltage DC instrument signal cable with black terminated on positive terminal and white terminated on negative unless otherwise noted.

J. Run direct current instrument conductors separately from alternating current conductors. Where allowed by NEC wiring classification, AC-DC route crossings shall be at 90 degrees. Install special sensor to transmitter cables in accordance with manufacturer's installation drawings or in compliance with manufacturer's instructions. Extra precautions shall be taken when pulling and shortening these "vendor furnished" cables. Any extra length on these cables shall be neatly coiled into minimum 3" diameter coils and installed into junction box.

K. All wiring terminating in a control panel/enclosure shall be landed on terminal strips, with one wire per terminal. All I/O points on a DDC/BAS controller shall be wired to panel-side of terminal strip, including all spare I/O points.

L. All communication/power/signal wiring terminating in a control panel/enclosure/junction box shall be provided with a minimum of 3” – 6” extra wiring length. Extra cable shall be loosely folded/looped and stored neatly in wireways or cable tray/headers above control panel.

M. Route intrinsic safe wiring separately from other conductors. These conductors shall not be run with, nor cross, conductors of other NEC classifications and shall require intrinsic barrier if run in the same path with wiring of other classifications.

N. Follow Control Contractor’s Company standard cabling color codes.

O. Suggested instrument and control conductor cables and color codes are as follows:

Type	Configuration	Colors	Manufacturer Part No.
120 VAC, 14 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9411
120 VAC, 14 AWG	3 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Gray PVC	Belden 9495
24 VAC, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
24 VAC, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Analog Input, 18 AWG	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Input, 18 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Input, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT	Belden 88770

Type	Configuration	Colors	Manufacturer Part No.
		Cond. 3 - RED Jacket - Red FEP	
Analog Input, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Analog Output, 18 AWG	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Output, 18 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Output, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Analog Output, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Discrete Input, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Input, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Output, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Discrete Output, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A

Type	Configuration	Colors	Manufacturer Part No.
General Purpose, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
General Purpose, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
General Purpose, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
General Purpose, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Intrinsically Safe Control Cable, 17 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Light Blue PVC	Anixter BL0012650
Intrinsically Safe Control Cable, 17 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Light Blue PVC	Anixter BL0012651

P. **[Control Contractor's Company] [Owner's]** standard cabling and color codes may be used instead of above specified cabling and color codes.

Q. Electric Signal Cables:

1. Analog electric signal cables from electronic transmitters to controllers/receivers and from controllers to other analog devices shall be continuously shielded to reduce effects of EMI on control signals residing on those cables. Electric signal cables to discrete devices typically do not require shielding, but for better noise immunity use twisted/shielded pairs.
2. Shields shall be grounded at power source end only and floated at other end. Pay particular attention to floating shields through termination points, maintaining only one single grounding point, and insulating from ground at other points.
3. Provide 250 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 1 - 5 VDC signals or 500 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 2 - 10 VDC signals from 4 - 20 mA control loop powered by 24 VDC power supply.

R. BAS Network Communication Cable:

1. Install special cable connectors in accordance with BAS manufacturer's recommendations.

2. Typically, #22 AWG, but no smaller than #24 AWG, twisted pairs, twisted shielded pairs, coaxial cable, fiber optics or manufacturer's standard cabling for communications between remote control devices and BAS controllers.
3. BAS Network communication cable shall not be spliced.
4. Provide isolated instrument grounding system as necessary per manufacturer's recommendations.

3.3 LOCAL CONTROL PANELS

A. Provide local control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served.

B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.

C. Label local control panels with respective unique ID numbers in accordance with Section 20 0553 - Mechanical Identification.

D. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.

E. Panel Layout:

1. Locate controllers in lower half of panel first and upper half second.
2. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.
3. Provide separate enclosure for 120 VAC power transformer and circuitry.
4. Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.
5. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.
6. Do not place controller or control devices on enclosure sides.
7. Do not use any control panel as wire or cable pass-through to adjacent panel.

3.4 BAS ETHERNET NETWORK TESTING AND BENCHMARKING

A. Test and document connectivity, latency, and integrity of network from each switch to each BAS controller and BAS server switch and from switch-to-switch.

1. Latency between any ports shall be equal to or less than 1 millisecond.
2. Packet loss shall be less than 0.5% between any ports when tested with frame sizes between 64 and 1518 frames for duration of 60 seconds.

B. Test and document all telecommunication protection/security techniques employed on system including access control into BAS Ethernet network from other building networks and access

control to other building networks from BAS Ethernet network. Coordinate testing procedures with Owner.

3.5 ADJUSTMENT AND COMPLETION CHECKLIST

A. After completion of installation, follow checklist procedure defined in checklist submittal to adjust and calibrate thermostats, control valves, control actuators, controllers, sensors, and other equipment provided in this Contract. Include signed and dated, completed checklist in Operation and Maintenance Manuals.

B. Upon completion of Work but before final acceptance of systems, Engineer or Owner's representative will verify performance of control loops. Control Contractor shall immediately remedy any deficiencies found. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program. Corrective modifications made by Control Contractor during warranty period shall be incorporated and updated in Operation and Maintenance Manuals.

C. After final acceptance of system, Contractor shall work with Owner to remove all existing user names and passwords for all software and hardware used on project and create new user names and passwords as required.

3.6 OWNER TRAINING

A. Provide full time BAS operator to run system after systems have been started and are regularly used until Owner has completed on-site training specified.

B. Provide minimum of 8 hours of on-site training to Owner's representatives. Conduct training sessions during normal business hours after system start-up and acceptance by Owner. Scheduling of training session(s) will be established by Owner. Portions of training may be performed before system is completely operational, but no sooner than one month before system is planned to be fully operational. Final training session shall be held after systems are complete including all graphics programming.

C. Course content shall include, but not be limited to, the following topics:

1. Explanation of control sequences. Include which sensors are used and how output device operates.
2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3. Walk-through of Project to identify controller locations and general routing of network cabling.
4. Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
5. Review of operation of operator's workstation; include hardware (PC's, printers, etc.).
6. Review of operator's workstation software using specific examples of operating hardware.
7. Review of portable operator's workstation software using specific examples of operating hardware.
8. Any additional item(s) specifically requested by Owner.

D. Provide listing of regularly scheduled factory classroom training sessions concerning advanced topics covering proper operation and maintenance of control systems, sensing, monitoring and control equipment. Additional classes travel and lodging will be arranged and paid by Owner.

E. Provide minimum of 8 hours of additional on-site training to Owner's Representatives, 6 months after initial training is completed.

F. Scheduling of training session(s) will be established by Owner.

END OF SECTION 230901

Qualification Form

Brief resume of **key** persons, specialists, and individual consultants anticipated for this project:

a. Name & Title:	b. Project Assignment:
c. Name of Firm with which Associated:	d. Years of Experience: With this Firm_____ Other firms_____
e. Education: Degree(s)/Year/Specialization	f. Responsibility Level Proposed for this Project:

g. Other experience and qualifications relevant to the proposed project (include training courses/certifications):

Recent Relevant Experience (see example below) ▪ Company, Location - Name of Specific Project, Facility - Description of Work and Responsibilities	**Qualifications**

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SECTION 230902 - CONTROL VALVES AND DAMPERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 2118 - Valves

C. Section 23 3314 - Ductwork Specialties

D. Section 23 3600 - Air Terminal Devices

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 GENERAL

A. Devices containing mercury are not allowed.

1.4 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.5 VALVE SELECTION AND SIZING

A. General:

1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°Fand all modulating butterfly valves over 60°F.
2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.
4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
5. Shut-off and 2-position valves shall be full pipe size.
6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.
7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Instrumentation Valves:

1. Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as follows:
   a. Compressed air/instrumentation air systems: ball or plug-type valves
   b. Water systems: globe-type valves
   c. Steam and condensate systems: gate-type valves
   d. Ductwork, air handling unit or air terminal device penetrations: ball or plug-type valves
   e. Liquid line sampling valves: multiple turn, metering-type valves.

C. Water Valves:

1. Select modulating control valves to provide 3-5 psi pressure drop at design flow rate with differential pressure less than 20 psi, and pressure drop equal to 25% of total pressure drop with differential pressure equal to or greater than 20 psi.
2. Design criteria for sizing modulating valves shall be based on 2 port, normally open, equal percentage valves unless otherwise specified. Select heating and cooling coil control valves of major equipment including air handling units for minimum of 30-50% of equipment sub-circuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balancing valve.
3. Select control valves based upon pressure drop calculations and Cv values at 100% stroke.
4. Size 3-way mixing or diverting valves not directly associated with pump subcircuit for 3-5 psi pressure drop.

5. Subcircuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

1.6 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure setpoints. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

A. General:

1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
2. Use 2 or 3 port normally open globe type control valves with equal percentage contoured throttling plugs for steam and water applications, except as otherwise noted.
3. Butterfly valves may be used for water system control valves 5" and larger provided that valves meet pressure and temperature requirements. High performance butterfly valves shall be used for modulating applications. General purpose butterfly valves may be used for 2 position control.

B. Globe Valves (Commercial Grade):

1. Manufacturers: Honeywell, Johnson Controls, Siemens Building Technologies, or TAC
2. Valves shall be bronze or brass body, threaded ends for steel piping, solder ends for copper piping, 150 psi rating for 2" and smaller; iron body, bronze mounted, flanged, 125 psi rating for 2-1/2" and larger.
3. Valves shall have stainless steel stems, spring-loaded Teflon packing, with replaceable stem/plug and packing kits.

C. Globe Valves (Industrial Grade):

1. Manufacturers: DeZurik/K&M, Fisher, Spirax Sarco, Samson Controls, Warren Controls or Valtek
2. Valves shall be iron or steel body, flanged, 150 psi rating.
3. Valves for standard use 2" and smaller shall be unguided, unbalanced equal percentage plug type. Valves 2-1/2" and larger shall be guided plug type with either top and bottom guides or cage restrained plugs. Valves with pressure drops greater than 50% of upstream pressure shall be cage type valves with sound reduction trim.
4. Valves shall have stainless steel stems, spring-loaded Teflon or Ethylene Propylene (EP) packing, replaceable metal seats and discs. Provide valve trim to limit audible sound levels to 85 dBA or less when measured at 5 ft.
5. ANSI Class IV shutoff. Valves shall conform to ANSI B16.10, ISA SP-75.

D. Characterized Ball Valves:

1. Belimo, Valve Solutions Inc., Bray Controls, Neles Controls or approved equal
2. Provide two-way or three-way modulating control valves as required.
3. Valves shall be ball-type valves with V-notch, segmented ball or characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring or other securing device to prevent the disk from movement during operation.
4. Valves shall be forged brass body, NPT threaded ends, 150 psi rating for 2" and smaller. Valve bodies 2-1/2" and larger shall be carbon steel or cast iron.
5. Valves shall be furnished with stainless steel ball and stem with fiberglass reinforced Teflon (RTFE) seats and Viton, EPDM or RTFE O-rings and seals.
6. Actuators shall be spring return type for valves requiring fail position; floating control, or fail last position type for areas such as animal rooms, offices or conference rooms.
7. Actuators for major equipment such as air handling units, heating hot water or chilled water shall be fail-in-place, fail open, or fail closed depending upon service requirements. Size actuators to achieve system shutoff pressures.
8. Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.

E. General Purpose Butterfly Valves:

1. Refer to Section 23 2118 - Valves. Refer to Damper and Valve Actuators in this Section for valve actuators.

F. High Performance Butterfly Valves:

1. Manufacturers: DeZurik, Xomox, Jamesbury, Posi-Seal, Bray/McCannalok or Fisher
2. Carbon steel body, lugged style, ANSI Class 150, adjustable PTFE packing, PTFE seat with suitable metal back-up ring, upper and lower shaft thrust bearings, 316 stainless steel one piece shaft and 316 stainless steel disc with offset shaft/disc design.
3. Normal and dead end (without downstream flanging) pressure rating shall be 275 psi.
4. Provide high voltage electronic actuator and positioner. Provide limit switches as required.
5. Valves and actuators shall be manufactured by valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by valve manufacturer.

G. Terminal Control Valves With Characterizing Disks (Reheat or Chilled Water):

1. Belimo, Johnson Controls, Siemens Building Technologies, Honeywell, TAC or approved equal

2. Provide two-way or three-way modulating control valves as required.
3. Valves shall be ball-type valves with characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring to prevent the disk from movement.
4. Valves shall be forged bass body with nickel plating, NPT threaded ends, 150 psig rating for 2" and smaller.
5. Valves shall be furnished with stainless steel ball and stem, and fiberglass reinforced Teflon seats and seals.
6. Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.
7. Actuators shall be spring return type for valves requiring fail position, floating control with fail last position type for areas such as animal rooms, offices or conference rooms.
8. Manufacturer shall warranty components for period of 5 yrs from date of production, with first 2 yrs unconditional.

2.2 CONTROL DAMPERS

A. General:

1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and 2-position (open/close) dampers shall be parallel blade type.
3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
4. AMCA Leakage Classification of Control Dampers

Class	**Static Pressure** Inches Water Column			
	1	4	8	12
	Leakage Rate cfm/ft^2			
IA	3	N/A	N/A	N/A
I	4	8	11	14
II	10	20	28	35
III	40	80	112	140

B. Standard Modulating and Two-Position Dampers:

1. Manufacturers and acceptable model numbers:
   a. Johnson Controls VD-1630 (airfoil type)
   b. Honeywell D2
   c. Ruskin CD50/CD60
   d. Air Balance AC-525/526
   e. Greenheck VCD-43/VCD-33

2. Damper frames shall be minimum of 16 ga galvanized steel or 14 ga extruded aluminum. Blades shall be minimum of 16 ga galvanized steel or 14 ga aluminum. Blades shall have maximum blade width of 8" with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity,

but not less than temperature range of -40° to 200°F, pressure differential of 6" WC, and approach velocity of 4000 fpm based on 4 ft damper section width.

4. Leakage rate shall meet AMCA Leakage Class IA or I.
5. Testing and ratings shall be per AMCA Standard 500-D.

2.3 SMOKE DAMPERS

A. Refer to Section 23 3314 - Ductwork Specialties, for Smoke Damper Specification.

2.4 DAMPER AND VALVE ACTUATORS

A. General:

1. Actuators shall have an electronic cut off or other means to provide burnout protection if stalled.
2. Actuators shall have a visible position indicator and provide position feedback to the controller as shown.
3. Provide manual hand wheel actuator or hand crank in addition to electric valve actuator to allow manual override.
4. Actuators located outside shall be provided with internal heaters.
5. Actuators located outdoors should operate in the ambient temperature range of -40°F to 120°F.
6. Actuators installed outdoors shall be NEMA 4X or IP66 rated or shall be provided with weatherproof NEMA 4X stainless steel enclosures (Belimo ZS-300 or equal) that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork.

B. Analog Electronic:

1. Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC
2. Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.
   a. Floating control actuators shall only be used for terminal hot water or chilled water control.
   b. Analog control actuators shall be used for all other modulating applications.
3. Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than 6 minutes.
4. Provide spring return feature for fail open or closed positions, as required by control sequence, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.
5. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.
6. Actuators for terminal heating/cooling equipment do not require spring return feature.

C. Discrete Two-Position Electric:

1. Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC
2. Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.
3. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.

PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.3 SMOKE DAMPERS

A. Refer to Section 23 3314 - Ductwork Specialties

B. Furnish smoke dampers as shown on drawings.

C. Smoke dampers furnished by Control Contractor will be installed by Mechanical Contractor.

3.4 ACTUATORS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, moisture, occupant safety, equipment protection, heating or cooling system protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail-closed.

B. Valve and damper operating speeds shall be selected or adjusted so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

C. Provide speed control valves for On/Off actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

D. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

E. Provide single actuator on damper section not exceeding torque capacity of actuator.

F. Multiple damper sections where used shall be connected together via jackshaft or other coupling device, not by internal pinned connections at blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuator shall be mounted directly to jackshaft or other coupling device for operating damper sections. For instances where damper actuator cannot be mounted to jackshaft or other coupling device, damper actuator shall be provided for each damper section.

1. Mounting multiple actuators to common damper jackshaft or valve stem to meet torque requirements is not allowed.

G. Position feedback potentiometers shall be provided where floating control actuators are sequenced with other floating control actuators in terminal hot water control (i.e., reheat valve, fin tube radiator valve, radiant ceiling panel valve, etc.).

H. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

I. Integral actuator end switches or feedback potentiometers shall not be used. Provide separate end switches/feedback potentiometers that provide actual damper/valve position.

1. Integral actuator end switches or feedback potentiometers can be used if damper or valve shaft is keyed or directly affixed to the actuator such that the shaft cannot slip and provide false position. U-clamp type actuator mounting always requires separate end switches/feedback potentiometers.

END OF SECTION 230902

SECTION 230903 - CONTROL INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 2120 - Piping Specialties

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Devices shall be indexed by bill of material for each system as detailed in Section 23 0901 - Control Systems Integration.

B. Device data sheets submittal shall be submitted simultaneously with Control Systems Integration submittal. Refer to submittals section in 23 0901.

C. Thermostat/Room Temperature Sensor Schedules:

1. Submit thermostat/room temperature sensor schedule with shop drawings. Thermostat/room temperature sensor schedule shall have detailed listing of which type is used for each room, including data concerning service and model numbers, sizes, cover types, and engineering data sheets for each control device.

D. Warranty

1. Provide 1 year warranty on all materials and labor.
2. Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

1.4 FCC COMPLIANCE

A. Digital equipment furnished under this Contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Instruments of same type shall be by same manufacturer, for instance, pressure transmitters, gauge, absolute, and differential pressure shall be of same manufacturer.

B. Pressure and temperature ratings of devices indicated in Part 2 - of this Section are minimum required. Devices shall be designed to withstand maximum pressures and temperatures encountered in respective systems.

C. No devices containing mercury will be allowed under this Specification.

2.2 GENERAL INSTRUMENTATION

A. Pressure Gauges:

1. Refer to Section 23 2120 - Piping Specialties

B. Thermometers (Dial-Type):

1. Refer to Section 23 2120 - Piping Specialties

C. Analog Electronic Instrument Indicators:

1. Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2" square. Output may be either analog needle type or digital with 1/2" high LED or backlit LCD displays.
2. Electronic indicators shall be marked in appropriate units (degrees, psi, % rh, gpm, cfm, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

2.3 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

1. Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of project. Terminal connections shall be made at terminal blocks inside of NEMA 1 enclosures unless otherwise specified. Outdoor units shall be NEMA 4 with concealed adjustment.
2. Ratings of normally open and normally closed contacts shall be adequate for applied load (minimum 5 amps at 240 Volts).
3. Accuracy of devices shall be ± 1% of scale with adjustable offset unless otherwise specified.

B. Temperature Low Limit Switches (Freezestats):

1. Electric 2-position type with temperature sensing element and automatic reset. Controls shall be capable of opening circuit if any one foot length of sensing element is subject to temperature below setting.
2. Sensing element shall not be less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, calibrate temperature switch setpoint to 38°F.
3. Manual reset to be provided by remote manual reset panel consisting of remote trip relays, master trip relay and master reset relay.
   a. Each freezestat operates its remote trip relay which is locked out upon freezestat trip. Indicator lamps at remote trip relay shall indicate which relay has tripped and therefore indicates which freezestat has caused trip.
   b. Remote trip relays will trip master trip relay that interfaces with BAS to cause air handling unit shutdown.
   c. Master reset relay is activated by reset pushbutton at remote manual reset panel to reset locked out trip relays and master trip relay.

C. Relays:

1. Manufacturers: IDEC, Potter Brumfield, Square D, or Allen Bradley
2. Equal to IDEC Type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 10A, 30 VDC, or 120 VAC. Coil shall match control circuit characteristics. DDC outputs shall be 24 VDC with maximum current burden of 50 milliamps. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.
3. Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.

D. Enclosed Relay (Relay-in-a-Box):

1. Manufacturers: Veris Industries, Kele & Associates, Functional devices, Inc. or approved equal
2. 1 or 2 SPDT relays in NEMA 1 or better enclosure. Coil shall be selected for control circuit characteristics.
3. Contacts rated at 10A, 28 VDC or 120 VAC. Conduit nipple is 1/2" NPT. Maximum coil current burden 50 milliamps.

E. Pressure Differential Switches (Air Systems):

1. Manufacturers: Cleveland Controls, Dwyer, Honeywell, Johnson Controls/Penn, Siemens Building Technologies, or TAC
2. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.
3. Pressure differential switches for air systems shall have pressure rating of at least 10" WC.
4. Pressure switches shall be automatically reset or manually reset. Refer to 23 0993 – Control Sequences for the specified type.
5. Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.
   a. Maximum Temperature Rating: 180°F
   b. Repeatability: ± 1%

F. Pressure Differential Switches (Water Systems):

1. Manufacturers: Allen Bradley, Ashcroft, Dwyer, Honeywell, Johnson Controls/Penn, Siemens Building Technologies, TAC, SOR, or United Electric

2. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.
3. Pressure differential switches for water systems shall be rated for 150 psig unless otherwise noted. Chilled water pressure differential switches shall be provided with totally sealed vapor tight switch enclosure on 300 psibody. Differential pressure switches to have 3-valve manifold for servicing.
   a. Maximum Temperature Rating: 300°F
   b. Repeatability: ± 1%

G. Target Type (Paddle) Flow Switches:

1. Manufacturers: Honeywell, Johnson Controls, Kobold, McDonnell & Miller, Dwyer or SOR
2. Adjustable set point, paddle type. Select switches for accuracy and ranges to match process conditions, electrical requirements, to implement intended functions.
3. Air sensing switches shall be for duct mounting, top, side, or bottom. Mounting in vertical duct with downward flow is not allowed.
4. Furnish water sensing switches with NPT fittings suitable for piping mounting. Switches shall be rated for 150 psig except chilled water switches shall be rated for 300 psi.

H. Position Switches (End Switches):

1. Manufacturers: Allen Bradley, Johnson Controls/Penn, Honeywell, Ruskin, Greystone Energy Systems, Reed National Air Products, NAMCO, Omron or Westlock
2. Provide damper position switches, as required to meet specified sequence. Rotary switches shall be cam action, lever, or proximity type. Provide damper brackets and connecting rods for connecting position switch actuation levers to damper blades or jackshafts.
3. "Tip Switches" or other position switches that contain mercury shall not be used for damper end switch applications.

I. Current Switches - Constant Load, Constant Speed:

1. Manufacturers: Veris Industries, N-K Technologies, Absolute Process Instruments, Kele & Associates, R-K Electronics or approved equal
2. These shall be Induction type sensors clamped over single phase conductor of AC electrical power and shall be solid-state sensors with adjustable threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
   a. Output: Solid state relay or relay contacts
   b. Trip Setpoint: Adjustable by multi-turn potentiometer
   c. Operating Temperature: 32 to 131°F
   d. Response Time: < 0.5 seconds

J. Current Switches - Variable Load, Variable Speed

1. Manufacturers: Veris Industries, N-K Technologies or approved equal
2. These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall consist of solid-state sensors with self-calibrating threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
   a. Output: Solid state relay or relay contacts
   b. Trip Setpoint: Self-calibrating through microprocessor
   c. Operating Temperature: 32 to 131°F

d. Response Time: < 0.5 seconds

K. Drain Pan Moisture Detector:

1. Manufacturers: Kele and Associates, DiversiTech or approved alternate.
2. Moisture detector is small, electronic control relay for detecting rising water levels, within drain pans or other containments. Moisture detector shall alarm when water levels reach 0.43” to prevent damage from overflow of drain pans. Relay shall reset when water levels decrease to 0.31” and relay re-energizes.
3. Relay is normally energized upon powering up and no water is present. When water level reaches the trip point the relay de-energizes for alarming in BAS.
4. Moisture Detector Relay Module (Model LD1-24):
   a. Supply Voltage: 24 VAC, 60 Hz
   b. Power Consumption: 1 W
   c. Cable length: 18-inches
   d. Relays Contacts:
      1). Type: SPDT
      2). Rating: 2.5A at 24 VDC; 5.0A at 120 VAC
   e. Enclosure Rating: Hermetically Sealed
   f. Dimensions: 0.87” H x 2.0” W x 1.25” L

2.4 ANALOG ELECTRONIC INSTRUMENTATION

A. Space Temperature Sensors:

1. Sensors shall be platinum RTD type, with the following minimum performance:
   a. Temperature Coefficient of Resistivity (TCR): 0.00385 ohm/ohm/°C
   b. Accuracy: ± .54°F + (0.005 X T) (Class B)
   c. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   d. Conformance: DIN-IEC 751
   e. Operating Range: 32 to 122°F, 0 to 99% rh

2. Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that device will maintain its accuracy within tolerance of ± 0.36°F between 32°F and 150°F, and 0.5°F between -20°F and 212°F.
3. Unless otherwise stated, space sensor cover shall be manufacturer’s standard plastic cover.
4. Provide visible setpoint, set point adjustment, and space temperature indication.

B. Duct Mounted or Insertion Temperature Sensors:

1. Platinum RTD type, with the following minimum performance:
   a. Temperature Coefficient: 0.00385 ohm/ohm/°C
   b. Accuracy: ± .54°F + (0.005 X T) (Class B)
   c. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   d. Conformance: DIN-IEC 751
   e. Operating Range: -50 to 170°F, 0 to 99% RH

2. Sensors mounted in pipes:

a. Install insertions sensors in stainless steel (carbon or stainless steel pipe) or brass (copper pipe) thermowells. Process coupling to be 3/8" or 1/2" NPT. Extension shall exceed insulation thickness by 1". Thermowell shall project into middle third of the process fluid when installed.
b. Sheath diameter shall not exceed 5/16". Length shall be such that sheath, containing sensor, projects into middle third of the process fluid when installed.
c. Connection head to be NEMA 4, cast iron, with screw on cap. Provide internal screw terminations for RTD and wire connection. Conduit connection shall be 1/2" NPT.

3. Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in area intake wells for air handling systems to avoid thermal effects from direct sunlight.
4. Sensors mounted in air streams, such as air handling units, supply ducts, exhaust ducts or return ducts, shall be averaging type. Averaging type sensor to be installed in ducts larger than 24" x 24" or greater than 576in^2. Mount averaging sensor across duct area in a “Z” pattern using mounting clips specific for averaging temperature sensor probes.
5. Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that the device will maintain its accuracy within a tolerance of ± 0.36°F between 32°F and 150°F, and 0.5°F between -20°F and 212°F.

C. Direct Insertion Temperature Sensors:

1. Sensor assembly shall be direct insertion, suitable for use with water systems, 150 lb class, minimum rating.
2. Sensor shall be platinum wound RTD, with the following minimum performance:
   a. Temperature Coefficient: 0.00385 ohm/ohm/°C
   b. Accuracy: ± .54°F + (0.005 X T) (Class B)
   c. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   d. Conformance: DIN-IEC 751
   e. Operating Range: -50 to 170°F, 0 to 99% RH

3. Sheath diameter shall not exceed 5/16". Length shall be such that sheath, containing sensor, projects into middle third of process fluid when installed. Material to be 304 or 316 stainless steel (carbon or stainless steel pipe) or brass (copper pipe). Process coupling to be 3/8" or 1/2" NPT.
4. Connection head to be NEMA 4, cast iron, with screw on cap. Provide internal termination for RTD and wire connection. Conduit connection shall be 1/2" NPT.
5. Provide hot tap assembly and extension. Material to be 304 or 316 stainless steel. Support hot tap at minimum of 2 points to eliminate vibration. Extension shall exceed insulation thickness by 1".
6. Refer to Section 25 3003 - Process Instrumentation Device Specifications.

D. RTD Temperature Sensor/Transmitters:

1. Manufacturers: Rosemount, Burns, Minco Products, Weed or Pyromation
2. Transmitters shall provide 2 wire, 4-20 mA current output signal proportional to specified temperature span of transmitter and compatible with DDC equipment.
   a. These shall be 100 Ohm platinum RTD type temperature instruments for process immersion or air duct mounting
   b. Operating Temperature: -20 to +180°F
   c. Power Supply Voltage: 13 to 35 VDC unregulated
   d. Accuracy or Output Error: 0.1% of span of sensor and transmitter combination

e. Temperature Coefficient: 0.00385 ohm/ohm/°C
f. Thermowells: By same manufacturer as Sensor/Transmitter or approved alternate.

3. Provide local temperature indicator with 3 LCD digital readout.

E. Space Humidity Sensors/Transmitters:

1. Manufacturers: General Eastern, Automation Components Inc., Veris Industries, Hy-Cal (Honeywell), Rotronic or Vaisala
2. Space humidity sensors shall be wall mount type with brushed aluminum or brushed nickel cover to match room thermostats and/or temperature sensors.
3. Sensing element shall be resistive bulk polymer, or thin film capacitive type. Sensor/transmitter shall have the following minimum performance:
   a. Accuracy: ± 2% rh at 25°C over range of 20-95% rh including hysteresis, linearity and repeatability
   b. Temperature Effect: Less than 0.06% per °F at baseline of 68°F
   c. Sensitivity: 0.1% rh
   d. Repeatability: 0.5% rh
   e. Hysteresis: Less than 1%
   f. Long Term Stability: Less than 1% rh drift per year
   g. Adjustment: ± 20% rh zero, non-interactive
      ± 10% rh span, non-interactive
   h. Operating Range: 0-99% rh, non-condensing, sensor
      0-95% rh, non-condensing, electronics
   i. Output: 4-20 mA, 0-100% linear, proportional
   j. Power: 12-36 VDC

F. Duct Mounted Humidity Sensors/Transmitters:

1. Manufacturers: General Eastern, Automation Components Inc., Versis Industries, Minco, Rotronic or Vaisala
2. Probe type, temperature compensated, resistive bulk polymer or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
   a. Accuracy: ± 2% rh at 25°C over 20-95% rh including hysteresis, linearity and repeatability
   b. Temperature Effect: Less than 0.06% per °F at baseline of 68°F.
   c. Sensitivity: 0.1% rh
   d. Repeatability: 0.5% rh
   e. Hysteresis: Less than 1%
   f. Long Term Stability: Less than 1% drift per year
   g. Adjustment: ± 20% rh zero, non-interactive
      ± 10% rh span, non-interactive
   h. Operating Range: 0-99% rh, non-condensing, sensor
      0-95% rh, non-condensing, electronics
   i. Output: 4-20 mA, 0-100% linear, proportional
   j. Power: 12-36 VDC

G. Combination Temperature/Humidity Transmitter:

1. Manufacturers: Automation Components Inc., Veris Industries, Vaisala, Minco or General Eastern

2. Combination Temperature and Humidity sensor/transmitter shall meet the following minimum requirements:
3. Temperature:
   a. Temperature Sensor: 100 or 1000 Ohm Pt RTD
   b. Temperature Coefficient: .00385 ohm/ohm/°C
   c. Accuracy: ± .54°F + (0.005 X T) (Class B)
   d. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   e. Operating Range: -10 to 160°F
   f. Supply Voltage: 18 to 36 VDC / VAC
   g. Output Ranges: 2-wire, 4 to 20 mA or 3-wire, 0 to 5, 0 to 10 VDC or 4 to 20 mA (24 VAC)

4. Humidity:
   a. Temperature Compensated: Full range of rh signal
   b. Response Time: 30 seconds for 63% step
   c. Accuracy Range: ±2% rh between 20 to 95% rh Span (including hysteresis, linearity repeatability).
   d. Sensing Element: Resistance or Capacitance humidity sensor
   e. Operating rh Range: 0 to 100% rh(non-condensing)
   f. Supply Voltage: 24 VDC (current or voltage output) 24 VAC (contact factory)
   g. Output Ranges: 4 to 20mA, 0 to 5V, 0 to 10V
   h. Long Term Stability: Less than 2% rh drift per year

5. Enclosure shall be made of ABS Plastic or equivalent and include an optional LCD display on face of enclosure.
6. Optional LCD readout shall be capable of °C or °F operation with an adjustable display toggle switch to change from temperature to humidity display. Unit shall include capability of temperature and humidity setpoint value display during adjustment.

H. Dew Point Temperature Transmitter:

1. Manufacturers: General Eastern, Kele & Associates or Vaisala
2. Microprocessor type primary dew point temperature measurement using platinum RTD, 4 wire, 100 ohm temperature sensing element with 4-20 mA transmitter.
   a. Accuracy: ± 1°F
   b. Repeatability: ± 0.1°F
   c. Hysteresis: None
   d. Sensor Range: -10°F to +140°F dew point
      32°F to 140°F ambient

3. Unit shall be selected for proper application (wall or duct mounted).

I. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:

1. Manufacturers: GE Modus, Setra, Ashcroft XLDP or approved equal
2. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
3. Unit shall be capable of transmitting linear 4 - 20 mA DC output signal proportional to differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:

a. Span: Not greater than twice duct static or velocity pressure at maximum flow rate, or more than 16 times velocity pressure at minimum flow rate.
b. Accuracy: ± 1.0% of span or ± 1.0% of full scale
c. Dead Band: Less than 0.5% of output
d. Hysteresis: Within 0.5% of span or within 0.5% of full scale
e. Linearity: Within 1.0% of span or within 0.5% of full scale
f. Repeatability: Within 0.5% of output
g. Response: Less than 1 second for full span input

4. Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from static pressure sensing stations and with static air probes to prevent migration of moisture and particulate matter into transducers. If inputs to pressure transducers/transmitters are dead-ended, integral air filters are not required. Supply air system sensors do not require integral air filters.

J. Differential Pressure Flow Element: Pitot Tube

1. Manufacturers: Dieterich Standard, Preso, Veris Inc. or approved alternate
2. These shall be averaging differential pressure type flow elements. Flow element shall consist of:
   a. Sensing tube with two internal chambers. One shall sense upstream pressure and one shall sense downstream pressure.
   b. These chambers shall have ports of quantity and size to accurately sense flowrate in piping line-size into which these are specified to be installed.
   c. Sensing tube shall have form so shaped as to minimize measurement inaccuracies.
   d. Sensing assemblies shall be provided with suitable supports to prevent damage to these assemblies at maximum flow-rate.
      1). Accuracy: Error ± 1.0% of sensor rated range
      2). Repeatability: Error ± 0.5%
      3). Sensor Materials of Construction: Stainless Steel unless otherwise noted
   e. Insert/Retract "Hot Tap" including insertion device and isolation valve:
      1). Each sensor, which is required to be Hot-Tap shall be provided with isolating valve, packing gland and retraction tube assembly.
      2). Each sensor that is specified to be installed into line in which pressure is greater than 200 psig, or for acid or caustic service, or for hazardous chemical service shall be provided with retaining hardware to allow mechanical retraction and insertion.
   f. Refer to Section 23 2120 - Piping Specialties for Flow Sensors, provided for balancing purposes.

3. Five-Valve Manifold shall be provided for each hydronic pressure differential transmitter. Manifold can be field assembled or purchased as an assembly and shall include the following:
   a. Two isolation valves
   b. Two vent valves
   c. One equalizing valve

K. Magnetic Flowmeter/Transmitter:

1. Manufacturers: Krohne, Fisher Rosemount, Invensys Foxboro or Yokogawa
2. Electromagnetic induction type with linear response proportional to flow rate. Selected span shall be not greater than twice design flow range. Select units for 10:1 turndown.

3. Unit shall be complete with 150 lb raised face flanged flowtube, PTFE, EPDM neoprene or PFA liner, magnetic coils, self-cleaning 316 stainless steel or Hastelloy C4 electrode, and 4-20 mA transmitter/power supply housed in NEMA 4 enclosure. Transmitter shall be fully field configurable microprocessor based unit.
   a. Minimum Accuracy: ± 0.5% of Span including hysteresis
   b. Repeatability: ± 0.1% of reading
   c. Operating Temperature: 0-125°F
   d. Power Requirements: 120 VAC / 60 Hz

4. Transmitter shall be integral mounted on flow meter.
5. Provide remote mounted indicator/transmitter. Indicator to be 1/2" LCD or back lit LED type.

L. Thermal Dispersion Air Flow Measurement Sensor/Transmitter:

1. Manufacturers: Ebtron or approved equal
2. Duct Mounted Flow Sensor:
   a. Multi-probe type thermal dispersion flow sensing station consisting of aluminum probe assembly with flanged connection and multiple hermetically sealed sensors in glass-filled polypropylene housing. Arrangement of sensors along probe assembly factory set to perform equal area traverse of duct cross section.
   b. Flow Sensor:
      1). Accuracy: ± 2% of reading
      2). Repeatability: ±0.25% of reading
      3). Materials: Probe – Aluminum
         Sensor Housing – Glass-Filled Polypropylene
         Mounting Brackets – 304 SS
      4). Calibrated Range: 0 – 5,000 fpm
   c. Temperature Sensor:
      1). Accuracy: ± 0.15%
      2). Sensor Temperature Range: -20°F to 160°F (0 – 1,500 fpm); 30°F to 160°F (>1,500 fpm)
      3). Humidity Range: 0 – 99%, non-condensing
      4). Probe Size Range: 8” to 120”
   d. Transmitter:
      1). Power Requirements: 24 VAC (22.5 to 29 VAC), 8 VA max.
      2). Enclosure: Aluminum Housing
      3). Outputs: 4 to 20 mADC
      4). Output Resolution: 0.025% of selected range
         a). Output 1: Airflow (0 – 5,000 fpm)
         b). Output 2: Temperature (-20°F to 160°F)
      5). Ambient Temperature: -20°F to 120°F

M. Current Transformers:

1. Manufacturers: General Electric, Square D, Kele & Associates, N-K Technologies or Veris Industries
2. Alternating current transformers shall conform to latest applicable Standards including AEIC, EEI-NEMA, Standards for Instrument Transformers (MSJ-11) and ANSI Standard C57.13 for instrument transformers.
   a. Rated Voltage: 480 V
   b. Insulation Class: 600 V
   c. Basic Impulse Level: 60 Hz

d. Short Time Current Rating: 100% (1 second)
e. Accuracy Class: 0.3
f. Continuous Current Rating: 150%

N. Rotary (Damper) Position Sensors:

1. Manufacturers: Kele & Associates, Fisher Controls or Westlock
2. Provide position 4-20 mA transmitter with potentiometer type (variable resistance) sensor for damper position measurement. Measurement to be linear to damper stroke.
   a. Performance:
      1). Power Supply: 24 VDC unregulated
      2). Accuracy: ± 1% of output span
      3). Repeatability: ± 0.5% of full span
      4). Maximum Temperature: 125°F

O. Space CO2 Sensors

1. Manufacturers: Vaisala, Automation Components Inc., Toxalert, BAPI or approved alternate.
2. Provide Carbon Dioxide Monitor as listed below. The system shall be a complete package with integral sensor, monitor, alarm contacts, local indication of current measured value for sensor.
   a. Gas to be Detected: Carbon Dioxide (CO2)
   b. Power Requirements: 24 VAC, 50/60 Hz, 50 VA
   c. Signal Input: Integral Sensor
   d. Signal Output: 4-20 mA DC or 0-10 VDC
   e. Alarm Relays: 1 Amps, 120 VAC, Form C
   f. Range: 0-2000 ppm
   g. Accuracy: ±75 ppm at 600 ppm and 1,000 ppm at sea level and 25°C
   h. Drift: ±5% of range over 5 years
   i. Sensor Infrared CO2 Sensor
   j. Mounting: Wall-mounted

3. Provide local display for continuous reading of CO_2 levels. Data shall be recorded on system with DDC to the zone level.
4. Unit shall have adjustable set points and self-test diagnostics.
5. Sensor shall have barometric compensation capabilities.
6. Certified by manufacturer to require calibration no more frequently than once every 5 years. Provide 120 VAC to 24 VAC transformer adjacent to Air Quality Monitor or provide 24 VAC from Temperature Control Panel nearest Air Quality Monitor.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment, wiring and air piping in neat and workmanlike manner and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc., required for proper operation of each device. Mark and detail on coordination drawings, exact locations of inline devices, wells, and taps to be installed by Mechanical Contractor.

B. Coordinate timely delivery of materials and supervise activities of other trade Contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished by Control Contractor which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. Mount motor control devices within 5 ft of disconnect switch, or starting device furnished by Electrical Contractor unless noted otherwise. Maintain required NEC clearances.

E. Control Contractor and Mechanical Contractor shall review proposed static pressure sensor and flow meter locations with Owner and Engineer for approval prior to installation.

3.2 GENERAL INSTRUMENTATION

A. Thermometers (Temperature Indicators):

1. Install thermometers at each point of temperature transmission and control, except for those that are indicated at local control panels. Install thermometers to permit easy reading from floor or operating platform (within 3 ft of line of sight). Provide remote bulb thermometers with readout indicators mounted within 3 ft of line of sight whenever sensing point is more than 3 ft from line of sight.
2. Thermometer wells in piping will be installed by Mechanical Contractor.

B. Local Control Panels:

1. Install remote mounted devices, controllers, I/O terminal blocks, power supplies, etc., inside of local control panels.
2. Locate panels as shown on drawings.
3. Locate panels adjacent to equipment served with minimum of 3 ft clearance in front of door. Provide sufficient clearances to allow full door swing and full access to internal components. Submit proposed panel locations with shop drawing submittals.
4. Mount top of panels between 5 and 6 ft above floor so that gauges and indicators are at eye level.

C. Pressure Gauges (Pressure Indicators):

1. Install pressure gauge for indication of supply and control pressure in pneumatic systems at output of controllers, I/P transducers, electric air solenoid valves, pressure switches and other points where visible indication of air pressure is required for operating and maintenance purposes.
2. Provide test port for quick connection of test gauges at valve, damper motor and other actuator branch lines.
3. Pressure gauge tappings in piping will be provided by Mechanical Contractor.

D. General Instrumentation at Local Control Panels:

1. Provide record control drawings of systems served by each local panel, in location adjacent to or inside of panel cover. Provide protective cover for drawing.

3.3 DISCRETE AND ANALOG INSTRUMENTATION

A. Wall Mounted Space Thermostats/Temperature Sensors:

1. Install space thermostats/sensors where indicated, as required to perform specified control sequences, and as directed to meet job site conditions.
2. Provide space temperature sensors without remote setpoint adjustment in all public spaces, hallways, and mechanical rooms unless otherwise specified.
   a. Mount space thermostats/sensors at 5 ft above floor unless otherwise indicated.
   b. Mount space thermostats/sensors with accessible setpoint adjustment or temperature reading (thermometer or digital temperature readout) at 4 ft above floor meeting ADA requirements.
3. Space thermostats/sensors located on exterior walls shall be mounted on thermally insulated sub-base.
4. Relocate space thermostats/sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
5. Mount space thermostats/sensors in corridors, stairways and public toilets 7 ft above floor.
6. Space thermostats/sensors in gymnasium, locker rooms, corridor, stairways, vestibules and toilets shall be aspirating type.
7. Space thermostats/sensors in gymnasium, locker rooms and, **XXX** shall be protected by heavy-duty cast and die formed guard.

B. RTD Temperature Transmitters:

1. Provide RTD temperature transmitters whenever DDCPs cannot receive RTD type inputs.

C. Low Limit Temperature Switches (Freeze Stats):

1. Install low limit controls where indicated on drawings or as specified. Unless otherwise indicated, install sensing element on upstream face of cooling coil where cooling coil is provided, or at downstream side of heating coils where no cooling coil is provided.
2. Distribute sensing element across entire area of medium being sensed. Install controls at accessible location with suitable mounting brackets and element duct collars where required.
3. For low limit temperature sensors installed on roof top units and other outdoor equipment, install heaters in enclosures housing freeze stats to prevent freeze stat tripping.

D. Static Pressure and Air Flow Stations:

1. Furnish static pressure and air flow measuring stations to Mechanical Contractor for installation.
2. Stations shall be installed in strict accordance with manufacturer's published requirements. These stations serve as primary signals for airflow control systems; therefore it shall be responsibility of Control Contractor to verify location and installation to assure that accurate primary signals are obtained.
3. Pressure differential switches shall be piped across device creating differential between fan discharge and fan suction.

E. Direct Insertion Temperature Sensors:

1. Install sensor so that sensor is pointed down stream.

F. Outside Air Temperature Sensors:

1. Mount on north side of building or in intake area wells for air handling systems. Provide solar shields for installations where sensors may be exposed to sunlight conditions.

G. Water Flow Meters and Flow Switches:

1. Install flow measuring devices with recommended straight pipe diameters upstream and downstream of elbows, tees, valves, or other fittings that cause uneven turbulent flow conditions.
2. If no recommendations are given, provide straight pipe equal to 10 pipe diameters upstream and 5 pipe diameters downstream.

H. Sensor Wells:

1. Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided that element is always in flow, (for condensate and other gravity return lines, install in bottom of pipe). Wells mounted in pipe 2-1/2" and smaller shall be installed at elbow tee fittings with well pointed upstream. Minimum of 2" pipe size for elbow tee installation.

I. Transmitters, Indicators, and Transducers:

1. Locate transmitters at sensing devices or within 100 ft of remote mounted transmitters. For hot systems (150°F and higher) mount electronics on side of pipe or remotely mount. For indicating type instruments, locate indicating element within 6 ft of floor with readout easily visible from floor level. Provide remote readouts if necessary.
2. Provide P-E transducers to convert analog pressure signals to analog electronic signals for input to DDC panels.
3. Provide pressure transducers integral to DDC panels or separate components to convert digital analog signals to variable pneumatic air pressure signals.

END OF SECTION 230903

SECTION 230923 - DIRECT DIGITAL CONTROLLERS AND NETWORKS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0903 - Control Instrumentation

C. Control Sequences: Refer to Drawings

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

1. ASC: Application Specific Controller. A networked device or node that contains a complete, configurable application that is specific to a particular task.
2. Alarms & Events: The exchange of data between devices related to the occurrence of a predefined condition that meets specific criteria (event).
3. BC: Building Controller. Provide supervisory control, scheduling, trend logging & alarm handling.
4. B-OWS: BACnet Operator Workstation
5. B-BC: BACnet Building Controller. Same as SLC.
6. B-AAC: BACnet Advanced Application Controller. Same as PPC.
7. B-ASC: BACnet Application Specific Controller
8. B-SA: BACnet Smart Actuator
9. B-SS: BACnet Smart Sensor
10. BBMD: BACnet Broadcast Management Device
11. BIBBS: BACnet Interoperability Building Blocks. Specific individual function blocks for data exchange between interoperable devices.
12. Broadcasting: The propagation of data from a device to the control network. Software objects that broadcast data to the network may include the following parameters:
13. Send on Delta: An adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data, this parameter defaults to a change of state. The broadcast of data is

	initiated when this criteria and the minimum send time requirement have been met. Also referred to as a “Change of Value”.
14. Minimum Send Time:	An adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.
15. Maximum Send Time:	An adjustable parameter that defines the maximum time period between broadcasts of a software object’s data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.
16. BTL:	BACnet Testing Laboratory.
17. Channel:	One or more segments not containing a router.
18. Domain:	A logical collection of devices on one or more channels.
19. FLN:	Floor Level Network. BACnet MS/TP.
20. HMI:	Human-Machine Interface. Graphical operator BAS interface. Same as Graphical User Interface (GUI).
21. LAN:	Local Area Network. Same as Floor Level Network.
22. Maximum Send Time:	Event driven communication parameter specifying the time period for which data must not be sent more than once.
23. Minimum Send Time:	Event driven communication parameter specifying the time period for which data must be sent at least once.
24. PICS:	Protocol Implementation Conformance Statement. Detailed description for a given BACnet device stating its inherent BACnet capabilities.
25. Point:	Group of data, which corresponds to a hardware input, output, or calculated value.
26. PPC:	Programmable Process Controller. Same as Advanced Application Controller (AAC)
27. Scheduling:	The exchange of data between devices related to the establishment and maintenance of dates and times at which specified output actions are to be taken.
28. Send on Delta:	Event driven communication parameter specifying the amount of variable change before data is to be sent between the Minimum and Maximum send times.
29. SLC:	Supervisory Level Controller. Same as Building Controller.
30. Segment:	A section of uninterrupted cable where multiple devices may be installed.
31. Subnet:	Logical division of a domain.
32. Trending:	The accumulation of (time, value) pairs at specified rates for a specified period duration.

1.4 SUBMITTALS

A. Shop Drawings:

1. Submit shop drawings for each hardware device used and submit complete description of software applications used. Submit manufacturer's printed product data sheets for each device or software program used. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing

each device manufacturer and full model number with links to device pages. Organize sheets in order of model number, alphabetically, then numerically. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.

2. Submittals shall include points list of each control input and output, controlled devices, locations of devices, and symbol or label of each control point in software.

B. Operating and Maintenance Manuals: Refer to Section 23 0901 - Control Systems Integration.

C. Software Manual:

1. As part of operating and maintenance manuals, submit one software manual per workstation plus one extra copy for archive use. Software manuals shall be divided into separate parts with tabs for each part.
2. Software manual parts shall include:
   a. Complete description of operating system including all commands, configuration programs, printouts, logs, database functions and passwords. Describe general operating procedures, starting with system overview and proceeding to detailed description of each software command feature with sample printed displays and system function description for each option. Include instructions on verifying errors, status, changing passwords and initiating or disabling control programs.
   b. Complete description of programming language including all commands, configuration programs, control loop functions and testing. Describe general programming procedures, starting with system overview and proceeding to detailed description of each software command feature. Include instructions on creating or modifying any control algorithm or parameter, debugging, etc. This shall include all control functions, algorithms, mathematic equations, variables, setpoints, time periods, messages, and other information necessary to load, alter, test and execute custom or pre-written programs.
   c. Software Backup: Upon successful completion of acceptance testing, submit to Owner 2 archive copies of all accepted versions of source code and compiled code for all application programs and data files on CD ROM backup disks. All control software must be readily accessible by Owner using BAS workstation hardware and software.
   d. Web server/data historian SQL database schema (table format) for trend data and event/alarm data.
   e. Control Loop Documentation: Submit indexed summary of each control loop program. Summary shall list in tabular form, name of system, name of control loop, all I/O points used, and reference to sheet number in shop drawings to describe control sequence programmed. For each control loop submit complete printed listing of source code used, all setpoints, high/low alarm points, time event schedules, proportional gains, integrals, derivative values, and other database values.
   f. BAS Points List Summary: Provide detailed summary for each point in the system. Summary shall be cross-index listing of all points in alpha/numerical order with list of control loops which use each point. For each point, include an abbreviated point name, expanded point description, detailed description of each input instrument or output device, and detailed description of exact location of all field hardware. Location descriptions shall include room names, column numbers, elevation (above ceiling, bottom of duct, etc.).

D. Graphic Samples: Submit sample graphics (one per type) for review and approval by Owner prior to starting graphics programming.

1.5 WARRANTY

A. Provide 1 year warranty on all materials and labor.

B. Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

1.6 FCC COMPLIANCE

A. Digital equipment furnished under this contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled to show this compliance.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) CONTROLLERS

A. General:

1. DDC controllers shall be microprocessor based, field programmable controllers, capable of performing control and energy management functions, and shall be UL listed as Signaling Systems. Each controller shall include its own microprocessor, power supply, input/output modules, and termination modules as required to perform intended function.
2. DDC controller shall receive discrete electrical and/or analog electronic field input signals, convert signals for use by controller, perform control sequences, convert controller information into output signals, and provide control output signals to actuators and field control devices. Inputs and outputs, including communication connections, shall be electrically or optically isolated from controllers.
3. All DDC controllers shall be provided by the same manufacturer.
4. DDC controller with analog input modules shall be capable of accepting any form of linear or non-linear voltage (0-5 VDC or 0-10 VDC), current (4-20 mA) or resistive input (0-1000 ohm).
5. DDC controller with discrete input modules shall be capable of accepting discrete inputs from any device with isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate input point status.
6. Provide input modules capable of interfacing with pulsed output type sensors as required.
7. DDC controller with discrete output modules shall have isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate output point status.
8. DDC controller shall have capability to scale, offset, and display proper analog value without field hardware modification. DDC controller shall convert analog input signals to digital values (A/D conversion) and convert digital values to analog outputs (D/A

conversion) for modulating control purposes. Some application specific controllers may utilize tri-state or Triac outputs for floating point control of control devices. Floating point control should be limited to non-critical room temperature control and mechanical space heating and cooling.

9. Failsafe hardware shall be provided such that BAS failures result in immediate return to local control. If DDC controller uses database values from other DDC controllers and communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.
10. Failure of network or control devices (i.e. building level controllers, floor level controllers, application specific controllers, routers, repeaters, etc.) shall be alarmed at the Operator Workstation as a Level 3 Critical Alarm.
11. All DDC Hardware shall meet the following requirements:
    a. All DDC controllers shall be connected to an ASHRAE 135 MS/TP, BACnet over ARCNET or BACnet/IP control network and communicate via ASHRAE 135 exclusively.
    b. MS/TP controllers shall operate at a minimum baud rate of 38.4 kbps.
    c. All DDCP shall implement all required functionality of the application network interface via BACnet objects, properties, and services.
    d. All DDC controllers shall conform to the BACnet Testing Lab's Device Implementation Guidelines and be BTL Listed.
    e. Application programs and configuration settings shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings.
    f. All settings and parameters used by the application shall be fully configurable to the greatest extent possible, via properties of BACnet objects that can be written to via BACnet services or via properties of BACnet objects that can be written to via BACnet services for the following:
        1). Setpoint
        2). Alarm limit
        3). Schedule modification
        4). Trend modification
    g. All other settings and parameters that cannot be written to via BACnet services shall be fully configurable via either properties of BACnet objects that can be written to with a configuration tool, or via hardware settings on the controller itself to support the application.

12. Each DDC panel shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in point schedules. If DDC controller does not have sufficient capacity, provide additional slave I/O panels to achieve required point count.
13. Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC panel. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control.

B. BACnet Building Controller (B-BC):

1. BACnet Building Controllers (B-BCs) shall provide direct connection to high speed, BACnet/IP Local Area Network (LAN) and Campus Ethernet network and serve as communications router for other controllers on slower speed BACnet MS/TP or BACnet over ARCNET Floor Level Network (FLN).
2. Communication between B-BC's shall be through BACnet/IP communication.

3. B-BC's shall have sufficient processor capabilities, hard-drive storage and RAM to implement all types of custom software applications and shall provide supervisory control, scheduling, trend logging & alarm handling functions as follows:
   a. Scheduling:
      1). Each B-BC shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.
   b. Trending:
      1). Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
      2). B-BC shall periodically upload trended data to networked BAS Web Application Server for long term archiving.
      3). Archived data shall be stored in standard database format and shall be made available for use in third-party spreadsheet or database programs.
   c. Alarm Generation:
      1). Alarms may be generated within the system for any object change of value or state either real or calculated. This includes analog object value changes, binary object state changes, and various controller communication failures.
      2). B-BC shall periodically upload alarm logs to networked BAS Web Application Server for long term archiving.
   d. Data Analytics/Fault Detection
   e. Automated Commissioning
   f. Advanced Alarm Management
   g. Measurement and Verification

4. B-BC's shall have uninterrupted real time clocks capable of time of day, week, and year information to the system as needed to perform software functions. Clock shall be programmed to reset twice per year to allow for Daylight Savings Time. Clocks in multiple DDC Controllers shall be synchronized to automatically match designated B-BC's or Web server. Accuracy shall be within 1 second per day.
5. Batteries shall maintain volatile memory and real time clocks for a period of at least 72 hours during power failure. Batteries shall be maintenance free and have minimum life of 2 years. When power has been restored, the following shall occur automatically:
   a. Orderly startup of controlled equipment (user defined)
   b. Continuation of control algorithms
   c. Database revision
   d. Logging of power interruption and restoration times
   e. Battery recharging

6. Provide local visual indication and system annunciation of low battery power for each battery.
7. Each B-BC shall include its own micro-processor, power supply, input/output modules, and termination modules as required to perform intended function.
8. BACnet UDP port number to always be set to 47808 (BAC0).

C. BACnet Advanced Application Controllers (B-AAC):

1. B-AACs are defined as having sufficient processor capabilities and RAM to implement all types of custom software applications.
2. B-AACs shall be capable of communicating to BAS network via BACnet MS/TP connected to Building Controller or via BACnet/IP directly.

3. All B-AACs controlling major mechanical equipment/systems and lab equipment monitoring shall communicate via BACnet/IP as indicated on BAS Network Architecture drawings.
4. Provide at least one extra communication port at each B-AAC for direct connecting a notebook computer or hand-held terminal.

D. BACnet Application Specific Controllers (B-ASC):

1. B-ASCs are defined as having standard software burned into EPROM, set points in EEPROM or RAM maintained by battery, and are designed to handle specific types of control sequences.
2. Application specific DDC Controller shall be capable of communicating to BAS network via low/medium speed network connected to B-BC.
3. Control outputs may be in the form of floating point control or true analog output control of end devices. Floating point control shall be limited to non-critical room temperature control or mechanical space heating and cooling.
4. Provide communication ports integral room temperature sensors/thermostats for interface with local terminal equipment controllers or a low range wireless (Bluetooth®) Commissioning tool that provides a temporary wireless connection between the MS/TP network and the laptop computer used to commission.

E. BACnet Router

1. BACnet MS/TP to BACnet/IP and BACnet/ARCNET to BACnet/IP Routers shall perform layer 3 routing of BACnet MS/TP or BACnet/ARCNET packets over an IP network in accordance with ASHRAE 135 Annex J. The router shall provide the appropriate connection to the IP network and connections to the BACnet MS/TP or BACnet/ARCNET network. BACnet Routers shall be capable of configuration via DHCP and Write-Broadcast-Distribution-Table messages but shall not rely on these services for configuration.
2. One router in the IP subnetwork shall be designated as the BBMD (BACnet Broadcast Management Device) and shall be indicated as so on the Network Architecture.
3. BACnet router functionality can also be incorporated into BACnet Building Controllers.

F. BACnet Gateways:

1. Provide gateways to connect BACnet to non-BACnet devices, and non-BACnet DDC controlled equipment.
2. Provide with each gateway an interoperability schedule, showing each point or event on the non-BACnet side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBS), defined in ASHRAE 135 Annex K. Provide two-year minimum warranty for each gateway, including parts and labor.
3. The following minimum capabilities are required:
   a. Gateways shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.
   b. Gateways shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from the BACnet network and vice versa where applicable.

c. Gateways shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.
d. Gateways shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBs, in accordance with ASHRAE 135.
e. Gateways shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

G. Power Supplies:

1. Power supplies shall operate on nominal 120 V, 60 Hz, single-phase power. DDC Controllers shall be provided with surge and noise protection. Power fluctuation shall not affect control system. Include surge protection on telephone line.
   a. Isolation transformers shall be included when connections are being made between 2 separate buildings.

2.2 DIRECT DIGITAL CONTROL SOFTWARE

A. General:

1. DDC Controller control strategies shall be Owner definable from engineering workstations.
2. Software functions and algorithms shall be sufficient to enable implementation of control sequences as specified and shall be able to maintain continuous control as intended.
3. Control functions shall include both mathematical and logical operators. Control algorithms shall include proportional, integral and derivative control (PID). Adaptive (self-tuning) PID loop parameters, if offered by DDC Controller manufacturer, shall not be used unless adaptive limits are used to adjust limit values based on system status; or written request is submitted and approved by Engineer.
4. Allow operators to assign unique identifiers of their choice to each connected point. Identifiers shall have at least 8 alpha/numeric characters. References to these points in programs, reports and command messages shall be by these identifiers.
5. Provide access control (user defined passwords) for system operation. There shall be minimum of 3 access levels. First level shall allow system monitoring only. Second level shall allow monitoring, set point adjustment, and scheduling revision. Third level shall allow modification of control algorithms. System shall return to secured (monitoring only) mode after 5 minutes of inactive operation.
6. Each DDC Controller shall contain self-diagnostics that continuously monitor proper operation of panel.
7. If microprocessor malfunctions, control loop outputs shall continue to function using last value received from microprocessor.

B. Building Controller Software:

1. Provide DDC Controller software application program modules for performing energy management control functions such as time of day change of database values (programmed start/stop, temperature setbacks, etc.), supply air temperature reset based on space load demand, economizer control, optimum start/stop based on current indoor

and outdoor psychometrics, duty cycling and client tailored programs required for special applications such as VAV fan matching and supply fan control, enthalpy control, intermediate season or "dead band" control, totalizing, and holiday programming.

2. Provide manufacturer's standard operating system for real time control of system interactions, including database information requests/transfers by system hardware or by operators. Operating system shall also have the following additional capabilities (given that operator has appropriate security access level):
   a. User interface and online system configuration software embedded in Building Controller.
   b. Support for Web services at the automation network level.
   c. Displaying database (point) value including measured values, controlled variables, setpoints, gain factors, and any other adjustable parameters.
   d. Changing or overriding any database value.
   e. Error detection, correction, re-transmission of database values, arithmetic or logical faults.
   f. Alarm reporting including sending alarms to remote workstations, User Interface Web Server or Data Historian on network.
   g. Alarm buffer to retain alarms in order of importance without losing any alarms.
   h. Creating and displaying historical trend logging of any value, limited only by available memory.
   i. Creating new variable database values (soft points) based on arithmetic calculation (including summation or totalizing) on other database values.
   j. Adding new hardware points without overall BAS shutdown.

C. B-ASC Controller Software:

1. Manufacturer's standard software for B-ASC's may be used only if control sequences can be implemented without modification. If control sequence cannot be accomplished with standard software, provide battery backed RAM or EEPROM DDC Controller (B-AAC) capable of being programmed for specified control sequence.
2. Provide software for portable PC units to communicate with terminal controllers at the room level network. Software shall allow access to modify, delete or create control strategies at the room sensor location.

2.3 OPERATOR'S WORKSTATION - HARDWARE

A. Workstations shall communicate with BAS on as-needed basis such that other executable programs may be processed without affecting control functions of BAS.

B. Operator Workstations shall communicate with BAS Web Server via standard web interface software. Provide Operator Workstations for operator interface to BAS for monitoring, control, and database management as indicated on BAS Network Architecture Drawings. Proprietary software shall not be required for proper monitoring and control of HVAC systems as specified in section 23 0924 - Graphical User Interface Integration.

C. Laminated plastic nameplates shall be provided for each workstation. Each nameplate shall identify the function, network address and identifier of the workstation. Laminated plastic shall be 0.125 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 0.25 inch high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.

D. Operator Workstation Hardware (workstation) shall be a laptop. The modular components of the laptop shall be products of a single manufacturer which advertises service in all 48 contiguous states. All laptops are required to have achieved Bronze registration or higher under the Electronic Products Environmental Assessment Tool (EPEAT).

E. Provide one operator's workstations for operator interface to BAS for monitoring, control, and database management.

F. Each workstation shall consist of the following as a minimum:

1. Case and 320 watt power, Energy Star compliant supply
2. Processor speed: 150% the stated requirements of the software to be installed on the workstation.
3. BIOS in Flash Memory
4. Sufficient expansion slots to be properly configured for its intended use
5. Random Access Memory (RAM): The greater of 2 GB or 150% the stated requirements of the software to be installed on the workstation with capacity for expansion.
6. Video Output Card:
   a. Desktop (Central Utility Plant): Dual Monitor, 512 MB, supporting at least 32 bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
   b. Desktop: 512 MB, supporting at least 32 bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
   c. Laptop: Support at least 16 bit color at a minimum resolution of 1024 by 768 at a minimum refresh rate of 60 Hz.

7. 101 key, keyboard with 12 function keys
8. Monitor:
   a. Laptop: LCD Screen sized as shown but no less than 12" with a maximum supported resolution of no less than 1024 by 768 pixels.

9. Communication Ports:
   a. Laptop: Three USB ports, one PCMCIA card slot, and one HDMI port.

10. CD-RW/DVD ROM 24X Drive
11. Hard Drive:
    a. Laptop: 250 GB formatted disk space with an average seek time of 10 milliseconds or less.

12. Network interface card:
    a. Laptop: Integrated Gigabit Ethernet NIC with an RJ45 connector and internal 802.11a/g/n wireless card.

13. All required cables for connecting to network and other remote devices
14. Mouse with mouse pad
15. UPS with 30 minute backup battery.
16. Software;
    a. The operating system (OS) shall fully support all installed software and peripherals and shall be able to obtain screen capture of the monitor display being viewed.
    b. Virus Protection Software shall consist of the project site's standard virus protection software complete with a virus definition update subscription.
    c. Latest version of Microsoft Office Professional
    d. Latest version of Adobe Acrobat.

2.4 ENGINEERING WORKSTATION

A. Refer to Operator Workstation section for requirements.

2.5 DDC ENGINEERING (PROGRAMMING) - SOFTWARE

A. Provide engineering software for one laptop.

B. Software shall have the same characteristic and capabilities as DDC Controllers. In addition, operator's workstations shall have the following features.

C. User Programmability:

1. Engineering workstation software shall include field-engineering tools (software & hardware) for programming all controllers supplied.
2. All application software shall be interactive, fully prompted, and menu driven and shall provide the following functionality as a minimum:.
   a. Determine control strategies, which have been defined for specific piece of equipment.
   b. Add control loops to system using English language type program language equal to BASIC or other easily learned language or function block programming. (PASCAL, C, or other assembly type languages are not acceptable.)
   c. Add points to system.
   d. Create, modify or delete control strategies.
   e. Create, modify or delete system graphics.
   f. Assign sensors and/or actuators to control strategy.
   g. Tune control loops through adjustment of control loop parameters.
   h. Enable or disable control strategies.
   i. Generate hard copy records of control strategies on printer or soft copies to files compatible with Microsoft Office applications.
   j. Select points to be alarmable and define alarm state(s).
   k. Select points to be trended over a period of time and initiate recording of values.
   l. Override Input/Output points for each individual controller.

2.6 OPERATOR WORKSTATION - SOFTWARE

A. Custom Database Functions:

1. Operator shall be capable of generating long term historical trend logs and displaying information in tabular or graphic formats. Provide all software options for standard and custom report generators.

B. Color Graphics:

1. Provide color graphics software package compatible with manufacturer’s standard software. Provide mouse or other special hardware required to operate software. Software shall be capable of user editing of text fields, graphics, alarms, and real-time variables.
2. Software shall be capable of importing files in AutoCAD format, directly or via translators.

2.7 NETWORK HARDWARE

A. Provide network interface hardware for each device connected to network. Each device shall have sufficient performance as not to degrade specified processing speed.

B. Provide network cabling with sufficient performance as not to degrade specified communication speed. Cabling shall be compatible with proposed system and shall comply with requirements specified in Section 23 0901 - Control Systems Integration.

C. Provide other network support devices that are required for proper operation of network, such as file servers, signal repeaters, network hubs, etc.

D. Provide network diagnostic tool for measuring/confirming bandwidth usage on IP layer.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment in neat, professional manner to satisfaction of Architect and Engineer.

B. Coordinate timely delivery of materials and supervise installation of DDC Controllers and network cabling and devices.

C. Install DDC Controllers and network control devices in accessible locations.

3.2 OVERALL BAS ARCHITECTURE

A. Provide hardware/software to update database in less than 1 second for fast-acting control loops such as pressure control, air or water flow rate control, and air handling unit temperature control, or 10 seconds or less for other control loops.

B. Control software algorithm and inputs and outputs for a single system or piece of equipment shall reside on a single controller and shall not be distributed amongst multiple controllers. If multiple pieces of equipment are to be interlocked, a single “Master” controller shall provide control for all interlocked pieces of equipment, i.e. an AHU and interlocked return fan and exhaust fans.

C. Control loop software algorithm for each analog control loop shall reside on same controller as inputs and outputs required for that specific control loop.

D. Networks that operate via polled response or other types of protocols that rely on central processors, file servers, or other such devices to maintain or manage peer-to-peer communications, shall have redundant components to maintain network in event of failure at central device. Provide automatic changeover (without operator intervention) to redundant device upon failure of any central type processor.

E. Floor Level Network (FLN) network shall be multi-drop digital transmission network utilizing BACnet MS/TP (38.4kbs) communication.

F. Each multi-drop trunk shall be within manufacturer's allowable line lengths without signal degradation. Multi-drop trunks shall be interfaced to system via standard EIA or other industry recognized interfaces so that single failure does not disrupt or halt network.

G. Communications between Building Level DDC Controllers and operator's workstations shall be peer-to-peer, allowing multiple users to access and use system simultaneously with no loss of system performance.

H. Provide levels of connected networks to connect all DDC Controllers, including terminal DDC Controller. Communications to terminal devices shall be similar to capabilities and functions of other DDC Controllers and shall be transparent to operator.

I. Quantity of nodes (devices connected) on any one FLN (MS/TP) shall not exceed 50% of maximum node capacity published by equipment manufacture and Building Controller processor usage shall not be greater than 30% nominal. Provide additional hardware to meet this requirement.

J. Alarm reports from DDC Controllers shall not be impeded by use of either remote or local monitor, or control stations on network either in access mode or programming mode.

K. Provide transient voltage surge suppression devices for controllers and other electronic devices requiring separate line voltage power source.

3.3 DIRECT DIGITAL CONTROLLERS

A. DDC Controller Usage:

1. Select DDC Controller to provide speed of response required for each control loop type. Pressure, flow rate, and air handling unit temperature control must be via Building Level DDC Controller. Application specific DDC Controller may be used for other control loop types.
2. Each DDC Controller shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in any point schedules. If DDC Controller does not have sufficient capacity, provide additional slave panels to achieve required point count.
3. Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC Controller. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control. Air terminal control loops may utilize floating point control from tri-state or Triac outputs from the controller, but require some type of feedback device to prove position.
4. Provide at least one Building Level DDC Controller per mechanical equipment room and, if required, at each PC workstation location.
5. For valves and dampers within 100 ft of associated DDC Controller, mount current to pneumatic (I/P) converter within DDC Controller panel or in adjacent panel. Otherwise mount I/P converters at valve or damper. Provide pressure gauges on main air, and all control output signals.

B. Point Capacity:

1. Provide point capacity required plus spare I/O point capacity in each B-AAC. Spare I/O point capacity is defined as terminal connections, which are ready to accept digital or analog inputs, dry contacts for digital outputs, and variable voltage or current terminals for

analog outputs. Universal type points are acceptable for both discrete and analog type points. Spare points do not include any input or output conversion devices.

2. Spare points in each B-AAC shall be as follows:
   a. 10% Digital Inputs
   b. 10% Digital Outputs
   c. 10% Analog Inputs
   d. 10% Analog Outputs

C. Building Controllers:

1. Provide one BBMD in each IP subnet.
2. BACnet UDP port number to always be set to 47808 (BAC0).

D. Application Specific Controllers:

1. ASC controllers serving critical spaces that require maintained space pressurization shall have an acceptable solution to the Auto-Zero/Auto-Calibration sequence if the submitted controller sensors require periodic automatic calibration. Control contractor shall provide one of the following solutions to eliminate loss of room pressurization:
   a. Auto-zero module
   b. Pressure transmitters/flow measuring sensors that require annual calibration.
   c. Control contractor shall provide a solution to the mechanical/controls engineer for approval.

E. Gateways:

1. Gateways may be used for communication with non-BACnet control hardware subject to all of the following limitations:
   a. Non-BACnet control hardware shall not be used for controlling built-up units.
   b. Non-BACnet control hardware shall not perform system scheduling functions.

F. Cabinets:

1. Provide local control cabinets for DDC Controllers. DDC Controller cabinets for air terminals may be used directly if enclosures are rated for NEMA 1. All cabinets shall utilize a single master key. Provide 2 spare key sets to Owner.
2. All control cabinets shall be labeled. Labels shall be keyed to the unique identifiers shown on the As-Built drawings

G. Controller Firmware

1. Provide latest version of controller firmware. Include firmware updates for period of one year after system acceptance, coinciding with warranty period. If the upgrade of firmware causes the need to upgrade or reconfigure/reprogram related systems, controllers or software, Contractor shall notify Owner prior to upgrade and provide additional work scope in coordination with other Contractors, as required, at no cost to Owner.

3.4 OPERATOR/ENGINEERING WORKSTATIONS

A. Security access levels for the engineering workstation software shall be setup as follows:

1. Guest (View-only) access level shall have the ability to perform the following tasks:
   a. View Data
   b. View Trends

2. Operator access level shall have the ability to perform the following tasks:
   a. View Data
   b. Acknowledge Alarms
   c. View Reports
   d. Override Points
   e. Change Setpoints
   f. View Trends
   g. Edit Schedules

3. Engineer access level shall have the same access as Operator level with the ability to perform the following additional tasks:
   a. Add Devices
   b. Address Changes
   c. Create Applications
   d. Download Applications
   e. Configure ASCs
   f. Setup Trends
   g. Setup Reports
   h. Modify Alarm Settings

B. Provide security access level setup for 10 users. Coordinate user names, access levels and passwords with Government.

C. System shall provide an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for 5 minutes. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

3.5 DDC SOFTWARE INSTALLATION

A. Operating system (OS): Contractor shall install the OS on workstations and laptops and configure user names and passwords.

B. Virus Protection software: Contractor shall install the virus protection software on each server, laptop and workstation and shall configure weekly virus scans.

C. Contractor shall install and configure all software packages required to maintain and configure all types of controllers provided as part of this project on each engineering workstation.

D. Software from panels shall be permanently stored on CD ROM and on at least one hard disk at operator's workstation or Web Application Server. Provide auto re-boot feature on power up from system failure. System failures shall not necessitate manual reprogramming to restore normal system function.

E. Provide the latest version of all standard software, including operating system and control software. Include any software updates for period of one year, coinciding with warranty period. Beta released software shall not be used.

3.6 INITIAL PROGRAMMING

A. Control Contractor shall provide initial programming of controllers to accomplish sequences specified.

B. Provide back-up documentation per software manual submittals for all programs, in both written and electronic media formats.

C. Outputs, whether sequenced or not, shall have separate programmable hardware outputs. For air handling units, minimum outside air, maximum (economizer) outside air, return air, relief air, smoke dampers, heating valves, cooling valves, humidifier valves, etc., shall each have separate output.

D. BACnet Naming and Addressing

1. Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For MS/TP, assign from range as indicated by vendor documentation.
2. Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.
3. Every BACnet Building Controller (B-BC) and BACnet Router UDP port number shall be set to 47808 (BAC0).
4. Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.
5. The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

E. Minimum BACnet Object Requirements

1. For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.
2. The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.
3. Support and provide Description and/or Device Type text strings matching signal type and engineering units shown on the points list.
4. Support and provide Inactive Text and Active Text property descriptions matching conditions shown on the points list.
5. For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. Enable the writeable Date List property and support all calendar entry data types.
6. Use Schedule Objects for all building system scheduling.

7. Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint and all constraints associated with Object, such as Proportional Constant, Integral Constant, and Derivative Constant for Loop Object, using BACnet read/write services.

F. Minimum BACnet Service Requirements

1. Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below.

Priority Level	Application
1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)
13	(User Defined)
14	(User Defined)
15	(User Defined)
16	(User Defined)

G. Data Sharing:

1. Data communication from Building Controllers to Engineering Workstation and BAS web server shall be programmed to use Change of Value (COV) data sending and not continuous data polling to limit net work traffic.
2. Data communication parameters for analog values shall be operator configurable and setup as follows:
   a. Minimum Send Time: 2 seconds
   b. Maximum Send Time: 60 seconds
   c. Send on Delta (COV) :
      1). Space Temperature: ±0.5°F
      2). Process Temperature: ±0.5°F
      3). Air Pressure, AHU: ±0.05“ W.C.
      4). Relative Humidity: ±0.5%
      5). Air Flow: ±200 cfm
      6). Water Flow: ±50 gpm
      7). Water Pressure ±0.2 psi
      8). Space Pressure: ±0.01“ W.C.

3. Digital data points shall be sent whenever a state change occurs.

H. Historical Trending:

1. All inputs and analog outputs shall be trended and shall fully configured and operational. Sample time shall be one minute.
2. Program historical file for run-times and quantity of start/stops of motor driven equipment
3. Trend logs are to be stored at the building controllers and uploaded to the BAS web server or data historian when the building controller trend buffer size reaches 90% full or every 30 minutes (FA).
4. Analog data points indicated in the DDC Point Schedules shall be have a sampling time of one minute and averaged over 15 minutes.
5. Digital data points indicated in the DDC Point Schedules shall be sampled upon change in value (COV).

I. Alarm/Event Management:

1. All alarm handling shall be fully configured with consistent alarm messages and priorities or category numbers to identify the system from which the alarm originates.

J. Provide programming of menus to assist new users in accessing screen displays of each point group. Point groups (user definable) shall be initially arranged by DDC Controller for major equipment and by floor and area for terminal devices. Terminal devices shall also be grouped by air handling system where applicable.

K. When adding to an existing system, groupings, tag names, descriptions, engineering units, etc. shall match the existing system. Transitions from the existing system to the new system shall be seamless in look, functionality, and operation. Controls Contractor shall verify with Owner if any standard naming conventions are being used and continue with those naming conventions when applicable.

L. Program historical file for run-times and quantity of start/stops of motor driven equipment.

M. Program maintenance alarms based on run-times and quantity of start/stops for motor driven equipment.

1. Provide the following additional alarms:
   a. Controller loss of communications for each controller.
   b. Controller battery alarm for each controller (where available)
   c. Out-of-range, bad, or missing data (fault) for each device.

N. Program alarms using the following levels:

1. Level 1 - Maintenance Alarm, requiring attention within 1 to 2 days. (Examples: 2-3°F temperature variance from set point; 15-25% relative humidity variance; etc.)
2. Level 2 - Low Level Alarm, requiring attention within 8 h, preferably during the same shift. (Examples: More than 3°F variance from set point, 30 percent relative humidity or more variance from set points; excess start/stops per day; etc.)
3. Level 3 - Critical Alarm, requiring immediate attention. (Examples: Non-operation of primary equipment; H-O-A overrides; failure of controllers, routers and repeaters.)
4. Level 1 and 2 alarms shall not interrupt current user operation, but shall be logged into alarm summary file, indicating status, acknowledgment, and by whom. Level 3 alarms shall

interrupt user via audible and/or flashing warning until acknowledged, without losing any work in progress. When alarms are acknowledged, program shall display point group or appropriate graphic display. Level 3 alarms shall also be logged into alarm summary file in similar manner as Level 1 and 2 alarms.

O. Automated Commissioning for VAV Air Terminal Devices:

1. Apply automated re-commissioning logic for VAV air terminal devices to allow operators, at any time after the building is occupied, to periodically activate an automatic comparison of the actual performance for any individual VAV terminal device to its baseline performance. The baseline performance shall be established in coordination with Test, Adjust, and Balance work and shall be recorded on the BAS for each and every air terminal device.
2. The automated BAS commissioning function shall report a customizable fault message to the operators if any actual performance parameters varies from the recorded baseline parameter by 20% (adjustable) or more.

P. Alarm management:

1. Monitor and direct alarm information to operator devices.
2. Generate custom written operator alarm message (to be developed by the Contractor and Owner in conjunction with the project) and advisories to operator I/O devices.
3. Perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost.
4. At no time shall the ability of the BLC/AAC to report alarms be affected by either a remote PC, local I/O device or communications with other panels on the network.
5. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
6. Authorized users shall have the ability to manually inhibit alarm reporting for each point.
7. Alarm destinations shall be included so that alarms are indicated and printed at a pre-defined FSU reporting device, or transaction log.
8. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) and/or based on priority.
9. Alarms shall directly send an alarm message to specified client PC destination or cause the execution of a connection to a remote device (owner to designate) and cause the execution of a communications connection to a remote wireless device (pager, hand held, email or Pocket PC device).
10. Alarm messages, and point graphic assignments alarms shall have accurate descriptions and response instructions, so that alarms may be quickly associated with appropriate graphic display.
11. Alarm reports shall be sent to multiple WEB connected PC's, cell phones or PDA's and shall send alarm reports.

Q. Time Schedules:

1. Provide time schedules for HVAC components/systems as indicated in Control Sequences.
2. All time schedules shall be fully configured with weekly schedules and all holidays identified by the Owner.
3. Time schedules are to reside in the Building Controllers.

3.7 POINT LIST

A. Provide points required to implement control sequences specified, whether or not they are listed in schedules. In addition to control points, provide additional points listed in point schedules or defined in Control Sequences.

B. All points shall be programmed with a point name and detailed description. Control contractor shall submit point naming convention to Laboratory/Engineer for approval prior to system programming.

C. Work jointly with Owner to develop point naming convention prior to start of programming.

3.8 AUTO-DIAL ALARM MESSAGES

A. Program up to 30 types of prerecorded voice or fax messages assigned to different alarm types. Assign up to 10 phone numbers for each message. BAS shall automatically call phone numbers without answering machines in predetermined order. If an acceptable phone response is not received after 6 rings (adjustable), system shall automatic retry 3 times (adjustable) before calling next number. Systems shall print level 3 alarm message if no phone numbers were reached.

3.9 GRAPHICS PROGRAMMING

A. Graphics shall be designed to match any existing graphic displays on the existing system when new system is to fully integrate with existing system. Transition from existing graphics to new graphics shall be seamless transition for operator in look, functionality, and operation.

B. On new system, program color graphic displays for each system as described herein. Graphic displays shall consist of pictorial presentations on display monitor/workstation with text description, system schematic, or picture; alarm fields; and database fields for all associated points, including dynamic input values, output values, set points, gains, time schedules, etc. Provide single keystroke access to text file description of control sequence(s) in detail.

C. Make use of color to highlight system components. Components of similar type shall be of same color for all graphics (example: dampers shall be purple, valves yellow, etc.). Alarm fields shall be flashing white letters on red background. Affected component shall also turn red whenever alarm status is indicated. Database fields shall be white letters on black background and shall be dynamically updated and re-displayed on screen by periodically polling database points not less than once every minute.

D. Utility Reports: Develop utility report graphics that show monthly totalized utility values compared yearly (for three immediately preceding years) for the following utilities:

1. Chilled Water
2. Heating Hot Water
3. Natural Gas
4. Steam – Domestic Heating Hot Water
5. Electricity – Mechanical Loads
6. Electricity – Interior Lighting
7. Electricity – Exterior Lighting
8. Electricity – Plug Loads

E. Alarming:

1. Coordinate all alarming requirements with Owner and demonstrate coordination with submittals.
2. The Contractor shall create enhanced alarm programs for all system points. These points shall be programmed for appropriate seasonal high or low alarm limits. Enhanced alarm programs shall prevent abnormal alarms from occurring when the associated system has been deactivated. For example: air handler mixed air, preheat, cooling, humidity, and static pressure control points, building chilled water, heating water system control points, etc. Alarms shall occur only while systems are active and being supplied with chilled/hot water or steam at normal operating temperatures and pressures. Alarm destinations, alarm messages, and point graphic assignments shall be included so that alarms are indicated and printed at a pre-defined Owner reporting device and recorded on a transaction log. Alarms shall have accurate descriptions and response instructions, so that alarms may be quickly associated with appropriate graphic display.
3. The Contractor shall define the specific system reactions for each point. Alarms shall be enhanced and prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. The Contractor shall initially define all point priority levels for handling of all system alarms. Users shall have the ability to manually inhibit alarm reporting for each point.
4. Alarm reports and messages shall be directed to a user-defined list of operator devices or PCs based on time (after hour destinations) and/or based on priority.
5. In addition to the points descriptor and the time and date, the Contractor shall create, print, display and store an alarm message for each point to more fully describe the alarm condition or to direct operator response. Alarm events may be configured to send an alarm message to a specified client e-mail address, cellular phone number via SMS text messaging.
6. Provide alarm suppression to minimize nuisance alarms from higher level alarms (level 1 is highest priority):

Level 1 Alarms	Level 2 Alarms	Level 3 Alarms
Chilled Water Temperature	Air Handling Unit Discharge Temperature	Room Air Temperature
Hot Water Temperature	Air Handling Unit Discharge Temperature	Room Air Temperature
Generator On or Power Lost to Building	Air Handling Unit and Exhaust Systems (Not on Emergency Power) Alarms	
Upon restoration of normal power provide delays and or other methods to suppress nuisance alarms during restarting of equipment.		
	Air Handling Unit Static Pressure	Room Pressurization and Flow Alarms
	Exhaust Fans Off	Room Pressurization and Flow Alarms

a. Graphic Displays:
   1). Coordinate all graphic requirements with the Owner and demonstrate coordination with submittals.
   2). Provide a color graphic system flow diagram display for each system with all points as indicated on the point list.
   3). Provide graphics for each floor plans of the building as a minimum. Size graphics to allow the operator to read room numbers and descriptions. Incorporate the capability to navigate section to section as required to view entire floor and to navigate floor to floor.
   4). Color shall be used to indicate normal and alarm conditions within all spaces. Color or common border lines shall be used to link HVAC equipment with zone(s) served.
   5). User shall be able to access the various system schematics and floor plans via a graphical penetration scheme and/or menu selection.
   6). User shall be able to penetrate from floor plan to associated HVAC system text based display.
   7). Create enhanced alarm programs for all system points. These points shall be programmed for appropriate seasonal high or low alarm limits.
   8). Refer to the following graphics guideline section and Graphic Standards for additional examples and samples.

F. Graphical Standard Guidelines

1. Display time, date, outside temperature and humidity on displays in same location on each graphic. Display command line with English prompt in same location on each graphic.

Provide command to direct specific displays without accessing main menu. Provide means of displaying directory of screens. Arrange displays by group and type.

2. Graphic displays shall be designed to be easily understood. When display screen is too cluttered due to size, limit information to important monitoring data. Provide sub-graphic(s) to display data not displayed on main display.
3. Graphics shall include, but not be limited to:
   a. Site Plans, including each building, building name, and status of all exterior points such as lighting, etc.
   b. Overall building plan, indicating location of mechanical rooms and areas served by each air handling unit.
   c. Floor plans for each area depicting locations of terminal units, areas served by terminal units, and other remotely located points. Plans shall include full height partitions, column numbers, room numbers, and room names with special functions (not offices, corridors, toilets, storage, etc.).
   d. Schematic type graphics for:
      1). Each air handling system
      2). Supply fan control loop
      3). Return fan control loop
      4). Cooling coil control loop
      5). Heating coil control loop
      6). Damper control loops
      7). All air terminal devices shown on floor plans
      8). Chilled water system showing all components
      9). Heating hot water system showing all components
      10). Lab and fume hood exhaust system.
   e. Large Area Floor Plan Graphic: When a link to a particular floor is selected, the screen will show an overall floor plan view divided into sections. This intermediate screen is necessary in large buildings where detailed floor plan view with room numbers and sensors displaying room air conditions are not possible. In the case of a building with floor plans containing few rooms per floor, this screen can be omitted. The floor plan will accurately represent the as-built layout of rooms in the building.
      1). The divisions of the partial floor plan sections should be based on the zones served by different air handling equipment. If that strategy does not produce the desired effects, the second best option is to divide the floor plan in equal parts.
      2). Each section will actively inform user of any alarm conditions within the section by changing from a green to red background color.
      3). Each section will have a link to take the user to a more detailed floor plan screen. In the bottom left hand corner of the screen are links to other floors arranged in a tree, the three shall also indicate alarm conditions present on each floor.
   f. Floor Plan Section: The floor plan section screen shows the floor plan layout in more detail with room numbers and sensors displaying room environmental conditions. Each sensor and room number act as a link to the corresponding room system graphic, room background color is green under normal operation and red when any of the analog or binary inputs are outside their alarm limits.
      1). The bottom left hand corner of the screen features links to different floors described previously, as well as a key plan of the sectioned view of the overall floor plan. Each section acts as an indicator and a link, when any room is in alarm mode in a particular section, that section turns red, otherwise it remains green. The user can move between section screens by selecting the

appropriate link. Bottom of the page will have links to associated as-built HVAC, electrical, and piping plans.

2). Locations of panel mounted static pressure sensors and building pressure sensors reference points will be indicated on the floor plan graphic.

g. General Lab: When user selects a link to general lab space the graphics link will bring up a room with relevant air valves and their associated control points. Air valves will have their respective tags displayed on their icons, (per as-built drawings). The air valve command position and air valve feedback will be listed next to each air valve.

1). The screen title block will list the room number with the air valves listed in the parentheses.

2). The air change rate information shall be calculated and based on the room volume and the air flowing out of the room. Positive rooms shall use the total supply and negative rooms shall use the total exhaust.

3). Zone temperature will have its effective/actual (after local adjustment) heating and cooling set-points listed, if temperature deviates outside those values the point will go into alarm mode.

4). All analog will have their corresponding set-points displayed, the parameter list button will be a link to all settings not shown on the room screen. The user will be able to change all settings, all analog and binary inputs will be read only points with the user having the ability to take them out of service.

h. Air Handling Unit – Supply: AHU screen title will show the equipment name.

1). All analog points will have their corresponding set-points displayed on the equipment graphic. When the input values are outside their respective set-points, their cells will turn red to show the user that the reading is in an alarm state.

2). The user will be allowed to override all output points (AO and DO) settings, all input (AI and DI) settings will be read only with an option of taking their value out of service.

3). The outside air damper and return air dampers will have their % open value command and feedback displayed in their indicator cells. The supply air damper status will be indicated by indicator cell and dynamically by making the damper blades move with respect to feedback information.

4). Fan status will be shown by color coding the fan wheel green and dynamically spinning the fan wheel when the fan is ON, when fan is OFF the fan wheel will not spin and the fan wheel color will be white. When fan is in alarm mode the fan wheel color will be red. When AHU is equipped with fan array all fans will be shown. VFD box above the fan will provide the user with active links to variable frequency drive integrated information. Supply fan VFD command cell will display the speed of the drive in 0-100%, if the VFD is allowed to exceed 60Hz during normal operation, 100% will correspond to the maximum speed the VFD is allowed to go to. Actual fan hz will be displayed.

5). Cooling coil valve command indicator cells will display the % open amount of valve full span and feedback. Chilled water returning from the cooling coil will have its temperature displayed in the indicator cell.

6). Filter status will be indicated in the cell and shall flash red when in an alarm state. Filter DP device settings shall be included in graphic when pressure settings are set locally.

7). Low temperature alarm, high static alarm and smoke alarm indicator cells will have a green background and display “Normal” when in normal mode, during alarm mode the cell background color will change to red and display will read “Alarm”.

8). Information used in discharge temperature reset control loop such as maximum zone temperature and humidity will be displayed in the corner of the screen.

i. Variable Fan Speed Exhaust System with Bypass Damper: Exhaust fan screen title will show the equipment name.

1). All analog inputs will have their corresponding set-points listed either on the equipment graphic or in the system parameter box. When the input vales are outside their respective set-points, their indicator cells will turn red to show the user that the reading is in alarm mode.

2). The user will be allowed to override all output points (AO and DO) settings, all input (AI and DI) settings will be read only with an option of taking their value out of service.

3). The bypass dampers will have their % open value and feedback displayed in their indicator cells. The damper status will be indicated by indicator cell and dynamically by making the damper blades move close when damper is closed and open when damper is open.

4). Fan status will be shown by color coding the fan wheel green and dynamically spinning the fan wheel when the fan is ON, when fan is OFF the fan wheel will not spin and the fan wheel color will be white. Fan status will be derived from the output power reading of the VFD. When fan is in alarm mode the fan wheel color will be red. VFD box above the fan will provide the user with active links to variable frequency drive integrated points. VFD command cell will display the speed of the drive in 0-100%, if the VFD is allowed to exceed 60Hz during normal operation, 100% will correspond to the maximum speed the VFD is allowed to go to. Indicator cell displaying fans lead-lag listing will be shown below each fan, as the fan rotation occurs, the indicator cells will display updated lead lag status in each cell.

5). Low static alarm indicator cells will have a green background and display “Normal” when in normal mode, during alarm mode the cell background color will change to red and display will read “Alarm”.

j. Variable Frequency Drive: Upon activation of a VFD link on any of the equipment screens the user will be directed to the VFD display screen. The name of the equipment will be displayed in the title block of the screen.

1). The picture of the VFD will show the actual piece of equipment installed in field. All available analog and binary inputs will be shown with appropriate names and units. When VFD is offline all of the indicator cells will turn black.

4. All system graphics shall include links to as-built control diagrams, sequences and product technical data.

5. System Summary Screens: Summary screens shall be developed for each system as described below. All summaries shall be customized for the specific project and application. All system summary screens shall be linked to the specific system graphic, floor plan and/or home page as applicable.

a. General system summary screens (can be generated within any reporting tool)
b. All points in the building.
c. All points in a user-defined group of points including per system log reports.
d. All points currently in alarm in the building.
e. All schedules.
f. All points in an override condition.
g. System specific summary screens.

h. Include an AHU terminal unit summary screen for each AHU that serves multiple terminal units. The summary screen shall include the following information and shall be continuously updated with real time data.

Air Terminal Summary													
Room #	Device ID	Room Temp	Room Target	SA Temp	CLG VLV Cmd	HTG VLV Cmd	Fan S/S	Fan Status	Heat/ Cool	Dmpr Cmd	Air Flow	AHU #	Design CFM

i. Within Air Terminal Summary graphic, the following equipment dynamic data will be displayed (AHU Summary) and Physical Plant information:

AHU Summary							
Unit #	SA Temp	RA Temp	CLG VLV Cmd	HTG VLV Cmd	VFD Speed	Static Pressure	Static Setpoint

Cooling Supply
Cooling Return
Cooling Flow
Cooling DP (for the associated building)
Heating Supply
Heating Return
Heating Setpoint
Heating Hot Water Pump Status Point(s)

j. Include a heating hot water terminal unit summary screen for each building. The summary screen shall include the following information:

Hot Water Reheat Summary			
Terminal #	Heating Coil Supply temp	Htg Valve Command	Actual Airflow
Total			

k. Include an AHU laboratory summary screen for each AHU that serves multiple laboratories. The summary screen shall include the following information:

Laboratory Air Terminal Summary											
Lab #	Supply CFM[1] Actual	General CFM[1] Actual	Fume CFM[1] Actual	CFM Offset Stpt	CFM Offset Actual	% Error	Reheat Valve Command	Htg Coil Sup Temp	Htg Stpt	Temp Actual	Clg Stpt
Total											

Note 1: Sum all supply air terminal, general exhaust terminals and all fume exhaust terminals as applicable.

General Note: $\%\text{Error} = \frac{\text{Actual Setpoint}}{\text{Setpoint}} \times 100\%$

END OF SECTION 230923

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SECTION 230924 - GRAPHICAL USER INTERFACE INTEGRATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0923 - Direct Digital Controllers and Networks

1.2 SYSTEMS DESCRIPTION

A. Building Automation System (BAS) Graphical User Interface (GUI) shall be accomplished via a web-server environment.

B. BAS web server shall communicate with individual Building Systems via BACnet/IP protocol on the Owner provided Enterprise Ethernet network.

C. Provide remote alarm paging via text message, alphanumeric message and email integral to web server software.

D. Operator workstations connected to building Ethernet network shall be able to access information as determined by Graphical User Interface (GUI) software through standard web browsing software (Internet Explorer, Mozilla Firefox or Netscape Navigator). GUI software shall allow transparent access to each connected building and building component/system for control and/or monitoring.

E. Building Campus currently has an existing JCI BAS Web server which provides system monitoring, alarming, scheduling, reporting and historical trend functions via graphical user interface.

F. Contractor shall integrate the new BAS provided under Section 23 0923 to the existing BAS Web Application Server.

1.3 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. This section specifies a system or a component of a system being commissioned as defined in Section 01 91 00 Commissioning. Testing of these systems is required, in cooperation with Owner and Commissioning Authority. Refer to Section 01 91 00 Commissioning for detailed commissioning requirements.

1.4 SUBMITTALS

A. Refer to Section 23 0901 - Control Systems Integration.

1.5 OPERATION AND MAINTENANCE MANUALS

A. Refer to Section 23 0901 - Control Systems Integration.

1.6 RECORD DRAWINGS

A. Refer to Section 23 0901 - Control Systems Integration.

1.7 OWNERSHIP OF PROPRIETARY MATERIAL

A. Refer to Section 23 0901 - Control Systems Integration.

1.8 WARRANTY

A. Refer to Section 23 0901 - Control Systems Integration.

PART 2 - PRODUCTS

2.1 BAS WEB APPLICATION SERVER – HARDWARE INTEGRATION INTO EXISTING SERVER

A. Provide all hardware required to integrate the BAS into the existing Campus BAS Web Application Server for operator control/monitoring of building control systems.

2.2 BAS WEB SERVER – SOFTWARE INTEGRATION INTO EXISTING SERVER

A. Provide all necessary software upgrades or additional licenses to accommodate the additional point capacity required to integrate all BAS monitoring and controls points. Refer to control diagrams.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all control equipment in neat and workmanlike manner to satisfaction of Architect and Engineer.

B. Coordinate timely delivery of materials and supervise installation of control devices.

3.2 SOFTWARE

A. Software shall be permanently stored on compact disk and on Web Application Server. Provide auto re-boot feature on power up from system failure. System failures shall not necessitate manual reprogramming to restore normal system function.

B. Provide the latest version of all standard software, including, operating system and application software. Include any software updates, and hardware updates associated with such software upgrades, for period of one year coinciding with warranty period. No beta released software shall be used.

3.3 OPERATOR WORKSTATIONS

A. Configure operator workstation with desktop shortcut to BAS Web Server and provide all necessary additional setup required for full functioning access to BAS Web Server environment including real-time process monitoring, alarm and event management, scheduling and trending.

3.4 BAS WEB SERVER – SOFTWARE AND GRAPHICS PROGRAMMING

A. Provide all necessary software programming to accommodate the additional point capacity required to integrate all BAS monitoring and controls points. Refer to Section 23 0923 – Direct Digital Controllers and Networks.

3.5 STARTUP

A. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 01 91 00 Commissioning.

3.6 FUNCTIONAL PERFORMANCE TESTS

A. System functional performance testing is part of the Commissioning Process as specified in Section 01 91 00. Functional performance testing shall be performed by contractor and witnessed and documented by Commissioning Authority.

END OF SECTION 230924

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SECTION 232114 - UNDERGROUND (DIRECT BURIED) PIPING

PART 1 - GENERAL

1.1 RELATED WORK

A. Excavation and Backfill: Refer to Division 31- Earthwork

B. Section 20 0520 - Excavation and Backfill

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This Section includes pipe and pipe fitting specifications and installation requirements for heating and cooling systems.

B. Specification of an item in this or any other section shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.

C. Use only new material, free of defects, rust and scale, and guarantee for services intended.

D. Use material meeting the latest revision of ASTM Specifications as listed in this Specification.

E. Follow local codes if they require other types of pipe or joints.

F. Use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.

G. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

H. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

I. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.

J. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:

1. B31.9 Building Services Piping

1.4 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes including, but not limited to, the following:

1. Name of system
2. Pipe: ASTM number, grade if known, type, wall thickness, material
3. Fittings: ASTM/ANSI number, grade if known, class, type, wall thickness, material
4. Joint type
5. Flanges: ASTM number, grade, class, type, material
6. Bolts and nuts: material
7. Flange gaskets: material, rating
8. Conduits: material, rating
9. Insulation: material, rating, thermal performance
10. Installation drawings including plans, sections, details
11. Type of welding
12. Welding Quality Control Program
13. Test pressure and media
14. Pipe flushing procedures
15. Pipe cleaning methods
16. All other appropriate data

B. Submit pipe certification as specified under Pipe Certification in this Section.

C. Submit required documents as specified under Pipe Welding in this Section.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish all pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.

B. Wherever possible, store all materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.6 PIPE WELDING

A. Procedure and Welding Qualification Records:

1. All Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work shall be submitted to Engineer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1 and B31.9, as applicable.
2. Unless otherwise indicated, welding shall be done using only the following processes:
   a. Shielded Metal Arc Welding (SMAW), also known as "stick: welding
   b. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding

c. Gas Metal Arc Welding (GMAW), also known as MIG welding
d. Flux-Cored Arc Welding (FCAW), a variation of GMAW
e. Submerged Arc Welding (SAW)

3. Root pass must be applied by only GTAW process with argon gas purge for stainless steel pipe.
4. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with B31.1 or B31.9, as applicable.
5. Back rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.

B. Quality Control Program:

1. Submit written quality control program for review and approval prior to implementing any welding on this project. Quality control program shall include the following as minimum:
   a. Explanation of how Contractor will assure proper fitup for each weld.
   b. Explanation of how Contractor will document welds performed by individual welding operators for systems under ASME B31.1.
   c. Explanation of how Contractor will assure that proper welding procedure is being followed.
   d. Credentials of personnel responsible for required weld examinations.

C. Weld Inspection and Examination:

1. Provide examination services for all welding for this project. Examination shall be in accordance with requirements of ASME B31, Table 136.4 or B31.9, as applicable. Personnel performing examination shall comply with requirements stipulated in 136.1 (A) through (E) or shall be AWS QC1 certified.
2. Periodically, as welding progress, Contractor shall submit report, signed by weld examiner, indicating status of project welding quality.
3. Arrange with Owner's Inspector for observation of fitup and welding methods prior to implementing any welds, including shop welds, on this Project.
4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.
5. Owner will examine selected welds utilizing radiography to confirm quality of welding work.

D. Welder Qualifications:

1. Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.
2. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.
3. Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.
4. Record of welding continuity shall include, at minimum, the following:
   a. Welder's employer name and address.

b. Date Welder Qualification Test was passed.
c. Dates indicating welding continuity.

5. Welders shall be qualified as required by ASME B3.1 or B31.9, as applicable. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by National Certified Pipe Welding Bureau.
6. Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in"6G position".

E. Weld Record:

1. For welding within the scope of ASME B31.1 Power Piping, submit to Engineer for approval an administrative procedure for recording, locating, monitoring and maintaining quality of welds to be performed on the project. This quality control document record shall include but not be limited to:
   a. Drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date, and WPS used.

1.7 PIPE CERTIFICATION

A. Certification is required for all pipe within scope of ASME B31.1. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

B. Type E or S Pipe:

1. Furnish manufacturer's mill certificate (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

C. Pipe Supports:

1. Pipes within outer casing shall be supported at not more than 10 ft intervals with galvanized steel supports. These supports shall be designed to allow for continuous airflow and drainage of conduit in place. Straight supports shall be designed to occupy not more than 10% of annular air space.
2. Supports shall be of type where insulation thermally isolates carrier pipe from outer conduit.
3. Surface of insulation shall be protected at support by sleeve not less than 12" long, fitted with traverse and, where required, rotational arresters.

D. Field Services:

1. Pre-insulated pipe manufacturer shall provide factory trained field service representative to train the installing personnel and verify all phases of installation are conforming to manufacturer's installation requirements.
2. This representative shall submit written reports to Owner/Engineer certifying that Contractor's installation is in accordance with manufacturer's recommendations at completion of installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Rovanco, Thermacor or Perma Pipe

2.2 CHILLED WATER PIPING.

A. Carrier Pipe:

1. Pipe: ASTM A53, Grade A or B, Type E or ASTM A106, Grade B, standard weight, black steel
2. Fittings: ASTM A234, Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
3. Flanges: Class 150 psi. Refer to Flanges in this Section

B. Insulation:

Minimum 1.5" polyurethane foam, 0.14 K(Btu·in/(h·ft^2·°F)) at 70°F, 2 pcf. Polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket.

C. Jacket:

1. 12" diameter, HDPE with minimum 175-mil thickness

2.3 FLANGES

A. Flanges:

1. ASTM A105, ASME B16.5, hot forged steel, welding neck pattern. Slip-on patterns are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe.
2. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full-face gaskets.
3. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of device connected to such as valves and piping specialties.

B. Flange Gaskets:

1. Gasket material to be asbestos free and suitable for pressure temperatures and fluid of piping system. Non-metallic gaskets shall be in accordance with AMSO/ASME B16.21 and ASTM F104. Unless otherwise indicated or recommended by manufacturer, gaskets shall be similar to Garlock IFG 5500 with 1/16" thick gasket.
2. Service Temperature (250°F thru 800°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

C. Bolting:

1. Bolts, bolt studs, nuts and washers shall have zinc plated finish.
2. Thread shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.
3. Threaded rods are not allowed as fastening elements.
4. For Class 150 and 300 flanges at 400°F or lower temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A307.

PART 3 - EXECUTION

3.1 FLANGED JOINTS

A. Clean flange surfaces and align flange surfaces parallel. Boltholes of gaskets shall be cut slightly larger than bolt diameter and gasket ID shall be slightly larger than flange ID.

B. Position gasket concentrically so compression is equally distributed over entire gasket surface.

C. Lubricate bolts and run nuts down by hand.

D. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.

E. Re-torque bolts 12 to 24 h after start up.

3.2 WELDED PIPE JOINTS

A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.

C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 60°F before welding.

D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.

3.3 WATER SYSTEMS

A. Pitch horizontal mains up at 1" per 40 ft in direction of flow.

3.4 PIPING SYSTEM PRESSURE TESTS

A. Coordinate pressure tests with Engineer and Owner at least 3 days in advance of its occurrence and conduct tests in presence of Engineer.

B. Conduct pressure test prior to flushing and cleaning of piping systems.

C. Conduct hydrostatic (HYDRO) test with test medium of water unless otherwise indicated.

D. If leaks are found, repair with new materials and repeat test; caulking will not be acceptable.

E. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

F. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 hrs plus such additional time as may be necessary to conduct examination for leakage.

G. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

H. Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

I. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system, due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

J. Conduct pressure tests with parameters indicated below:

System	Test Pressure	Remarks
Chilled water	100 psig	HYDRO

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

A. Flush all water, steam and condensate systems thoroughly for 15 min or longer, as required to ensure removal of all dirt and foreign matter from piping system.

B. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead end supply and return headers as necessary.

C. After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold-water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

3.6 UNDERGROUND PIPING

A. General:

1. Install below grade piping as indicated on the drawings and according to the manufacturer's instructions and installation drawings.
2. Perform hydrostatic pressure test as herein specified for each underground piping system. Repair any leaks and retest until a successful test has been completed. Contractor to drain water used for hydrostatic test, to the sanitary sewer.
3. Contractor to provide means for conducting drain water from the underground piping to storm sewer, i.e., pumps, hoses, piping, etc.
4. Contractor to furnish all labor and equipment required to perform hydrostatic test and draining of piping.
5. After each piping system has been successfully hydrostatic tested, backfill that system as specified in Division 31 or in accordance with the manufacturer's recommendation. Hydrostatic test shall be repeated until a successful hydrostatic test has been completed.
6. All installation of pre-insulated pipe systems shall be done in strict accordance with requirements specified in this Section and manufacturer's instructions.

B. Earthwork:

1. Provide excavation, dewatering, backfilling, and shoring as specified in Division 3102 and as recommended by the manufacturer. Comply with all local codes and safety ordinances related to this work. Trenches shall be dug to depths indicated on drawings. Bedding of piping systems shall be in accordance with manufacturer's installation instructions.

C. Welding:

1. All welding shall meet the requirement specified in this Section. All welding shall be butt-weld.

D. Testing:

1. Carrier pipes shall be hydrostatically tested in accordance with requirements in this Section before backfilling. Contractor to drain all water used for hydrostatic test to sanitary sewer.
2. System outer conduit shall be air tested at 15 psig for a period of one hour. System may be tested in stages, utilizing test caps provided by conduit system manufacturer, but even conduit field closure shall be tested.
3. Field test for density of soil compaction shall be performed in sufficient number to ensure that the specified density is obtained. The tests shall be in accordance with ASTM D1557-78 or ASTM D2992 and D3017.
4. Engineer shall be notified 48 h prior to any test. Contractor shall submit test reports on every test indicating date of test, sections tested and beginning and ending pressure recorded.

END OF SECTION 232114

SECTION 232116 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 22 1600 - Natural Gas Piping

B. Section 23 0594 - Water Systems Test Adjust Balance

C. Section 23 0902 - Control Valves and Damper (Valves)

D. Section 23 0903 - Control Instrumentation (Wells, Taps or In-line Devices)

E. Section 23 2118 - Valves

F. Section 23 2120 - Piping Specialties

G. Section 23 2514 - Chemical Treatment Systems (Pipe Cleaning)

1.2 [REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]**

1.3 DESCRIPTION

A. Specification of an item in this or any other sections shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.

B. Use only new material, free of defects, rust and scale, and guarantee for services intended.

C. Use material meeting the latest revision of ASTM specifications as listed in this specification.

D. Follow local codes if they require other types of pipe or joints.

E. Use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.

F. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

G. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

H. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.

I. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:

1. B31.9 Building Services Piping
2. B31.5 Refrigeration Piping

J. Non-metallic piping is acceptable only for services indicated. It is not acceptable in occupied spaces and ventilation plenum spaces.

1.4 DEFINITIONS

A. When used in this section, the term Chilled Water shall include Chilled Beam Water as well as Chilled Water.

1.5 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes including, but not limited to, the following:

1. Name of system
2. Pipe; ASTM number, grade if known, type, wall thickness, material
3. Fittings; ASME number, grade if known, class, type, wall thickness, material
4. Joint type
5. Flanges; ASTM number, grade, class, type, material
6. Bolts and nuts; material
7. Thread joint sealants; material
8. Flange gaskets; material, rating
9. Unions; ASTM number, type, material, rating
10. Type of welding
11. Welding Quality Control Program
12. Test pressure and media
13. Pipe flushing/cleaning plan
14. Pipe cleaning method
15. All other appropriate data

B. Submit pipe certification as specified under Pipe Certification in this Section.

C. Submit required documents as specified under Pipe Welding in this Section.

D. LEED Submittal

1. Product Data for IEQ Credit 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.

B. Where possible, store materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.7 PIPE WELDING

A. Procedure and Welding Qualification Records:

1. Submit Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work to Engineer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1 and B31.9, as applicable.
2. Unless otherwise indicated, welding shall be done using only the following processes:
   a. Shielded Metal Arc Welding (SMAW), also known as "stick" welding
   b. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding
   c. Gas Metal Arc Welding (GMAW), also known as MIG welding
   d. Flux-Cored Arc Welding (FCAW), a variation of GMAW
   e. Submerged Arc Welding (SAW)
3. Root pass must be applied by GTAW process with argon gas purge for high-pressure steam and condensate (400 psig and over) and high temperature hot water (450°F and over) services.
4. Root pass must be applied by only GTAW process with argon gas purge for stainless steel pipe.
5. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with ASME B31.1 or B31.9, as applicable.
6. Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.

B. Quality Control Program:

1. Submit written quality control program for review and approval prior to implementing any welding on this project. Quality control program shall include the following as minimum:
   a. Explanation of how Contractor will assure proper fitup for each weld.
   b. Explanation of how Contractor will document welds performed by individual welding operators for systems under ASME B31.1.
   c. Explanation of how Contractor will assure that proper welding procedure is being followed.
   d. Credentials of personnel responsible for required weld examinations.

C. Weld Inspection and Examination:

1. Provide examination services for all welding for this Project. Examination shall be in accordance with requirements of ASME B31.1, Table 136.4 or B31.9, as applicable.

2. Periodically, as welding progresses, submit report, signed by weld examiner, indicating status of project welding quality.
3. Arrange with Owner's Inspector for observation of fitup and welding methods prior to implementing any welds, including shop welds, on this Project.
4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

D. Welder Qualifications:

1. Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQS) as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.
2. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.
3. Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.
4. Record of welding continuity shall include, at minimum, the following:
   a. Welder's employer name and address
   b. Date Welder Qualification Test was passed
   c. Dates indicating welding continuity

5. Welders shall be qualified as required by ASME B31.1 or B31.9, as applicable. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by National Certified Pipe Welding Bureau.
6. Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in "6G position."

1.8 PIPE CERTIFICATION

A. Certification is required for all pipe within scope of ASME B31.1. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

B. Type E or S Pipe:

1. Furnish manufacturer's mill certificates (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

1.9 FLANGES

A. Use either flat faced or raised-face flanges for mating with flat-faced or raised-face flanges.

B. Where allowed under specific piping systems specified in this section, use of Low Strength (ASTM A307) bolts shall be limited to service temperatures of 400°F and used only with non-metallic flat ring gaskets.

PART 2 - PRODUCTS

2.1 HEATING HOT WATER

A. 2" and Smaller:

1. Pipe: ASTM B88 seamless, Type L, hard temper copper tube
2. Fittings: ASME B16.22, wrought copper solder joint
3. Joint: ASTM B32, lead free solder, similar to Bridgit, Silvabrite, Silverflow or Canfield
4. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4" and smaller. Unions shall be used for line sizes over1".
5. Flanges: ASME B16.24, Class 150, cast copper alloy
6. Bolts and Nuts
   a. Type 316 stainless steel bolts conforming to ASTM A193, Grade B8M Class 1 or Class 2 with Type 316 stainless steel nuts conforming to ASTM A194, Grade 8M. Use 316 SS washers.

7. Gaskets:
   a. ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.
   b. Gasket thickness 1/16”
   c. Maximum Seating Stress (*y*) 3050 psi
   d. Minimum Gasket Factor (*m*) 4.2

8. Use solder joints for valves and piping specialties in copper piping
9. Press Joint Option:
   a. Contractor may use press copper fittings as manufactured by Viega, Other acceptable manufacturers are Nibco and Elkhart. “Push-to-connect” or “push-in” fittings, which are not press-type, will not be accepted.
   b. Fittings: Copper press fittings with EPDM seal, 0 to 250°F, maximum 200 psi.
   c. Joints: Press joints by fitting manufacturer approved tool.

B. 2-1/2” and Larger:

1. Pipe: ASTM A53, Grade B, Type E or Sor ASTM A106, Grade B, standard weight, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
3. Flanges:
   a. ANSI Class 150, ASTM A105, ASME B16.5 or ASME B16.47 Series A or B, welding neck

4. Bolts and Nuts:
   a. ASTM A193, Grade B7 or B16 with nuts conforming to ASTM A194, Grade 2H.

5. Gaskets

a. ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.
b. 2-1/2” thru 12”
   1). Gasket thickness 1/16”
   2). Maximum Seating Stress (*y*) 3050 psi
   3). Minimum Gasket Factor (*m*) 4.2
c. 14” and larger:
   1). Gasket thickness 1/8”
   2). Maximum Seating Stress (*y*) 4400 psi
   3). Minimum Gasket Factor (*m*) 5.2
d. Garlock, Klingersil or J.M. Clipper, similar to Garlock 3000.

C. Contractor may use carbon steel as specified below in lieu of copper tube for 2" and smaller.

1. Pipe: ASTM A53, Grade B, Type E or S or ASTM A106, Grade B, standard weight, carbon steel
2. Fittings: ASME B16.4, Class 125, cast iron, threaded or ASME B16.3, Class 150, malleable iron, threaded
3. Unions: ASME B16.39, black malleable iron ground joint, bronze or brass to iron, Class 250

2.2 CHILLED WATER

A. 2" and Smaller:

1. Pipe: ASTM B88 seamless, Type L, hard temper copper tube
2. Fittings: ASME B16.22, wrought copper solder joint
3. Joint: ASTM B32, lead free solder, similar to Bridgit, Silvabrite, Silverflow or Canfield
4. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for lines sizes 3/4" and smaller. Unions shall be used for line sizes over 1".
5. Flanges: ASME B16.24, Class 150, cast copper alloy
6. Bolts and Nuts:
   a. Type 316 stainless steel bolts conforming to ASTM A193, Grade B8M Class 1 or Class 2 with Type 316 stainless steel nuts conforming to ASTM A194, Grade 8M. Use 316 SS washers.

7. Use solder joints for valves and piping specialties in copper piping.
8. Press Joint Option:
   a. Contractor may use press copper fittings as manufactured by Viega. Other acceptable manufacturers are Nibco and Elkhart.
   b. Fittings: Copper press fittings with EPDM seal, 0 to 250°F, maximum 200 psi.
   c. Joints: Press joints by fitting manufacturer approved tool.

B. 2-1/2" and Larger:

1. Pipe: ASTM A53, Grade B, Type E or S or ASTM A106, Grade B, standard weight, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
3. Flanges:
   a. ANSI Class 150, ASTM A105, ASME B16.5, welding neck

4. Bolts and Nuts:
   a. ASTM A193, Grade B7 or B16 with nuts conforming to ASTM A194, Grade 2H.

5. Gaskets
   a. ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.
   b. 2-1/2” thru 12”
      1). Gasket thickness 1/16”
      2). Maximum Seating Stress (*y*) 3050 psi
      3). Minimum Gasket Factor (*m*) 4.2
   c. 14” and larger:
      1). Gasket thickness 1/8”
      2). Maximum Seating Stress (*y*) 4400 psi
      3). Minimum Gasket Factor (*m*) 5.2
   d. Garlock, Klingersil or J.M. Clipper, similar to Garlock 3000.

C. Contractor may use carbon steel as specified below in lieu of copper pipe for 2" and smaller.

1. Pipe: ASTM A53, Grade B, Type E or S or ASTM A106, Grade B, standard weight, carbon steel
2. Fittings: ASME B16.4, Class 125, cast iron, threaded or ASME B16.3, Class 150, malleable iron, threaded.
3. Unions: ASME B16.39, black malleable iron ground joint, bronze or brass to iron, Class 250

2.3 RAW WATER MAKE-UP

A. Refer to Section 22 1118 - Water Distribution System

2.4 CHEMICAL TREATMENT

A. Closed Water System (Hot Water, Chilled Water, Glycol, etc.):

1. Use pipe and fittings as indicated for the system to which chemical treatment piping is connected.

2.5 VENTS AND RELIEF VALVES

A. Unless otherwise indicated, use pipe and pipe fittings as indicated for the system to which relief valve or vent is connected.

2.6 PRESSURE GAUGES AND TAPPINGS

A. Use pipe and pipe fittings as indicated for the system to which pressure gauge or tapping is connected. Use "Threadolets", "Sockolets" or tee fittings for tappings. Refer to Part 3 under General for use of "Threadolets" and "Sockolets".

B. Gauge pipe shall be 1/4" unless otherwise indicated.

C. Gauge pipe shall be 1/2" for high pressure steam (101 psig and over) systems.

2.7 COOLING COIL CONDENSATE DRAIN

A. Piping shall be one of the following, unless otherwise indicated on drawings:

1. Copper
   a. Pipe: ASTM B88, Type M, hard temper copper tubing
   b. Fittings: ASTM B16.22 wrought copper fittings
   c. Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite

2.8 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL PIPE TO COPPER PIPE)

A. 2" and Smaller:

1. Use bronze ball valves specified in Section 23 2118 for dielectric purpose.
2. Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used in lieu of dielectric unions for pipe sizes 2" and smaller.
   a. Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig.

3. ASTM A197/ASME B16, equal to Stockham Figure 693-1/2, Watts Series 3000 or Wilkins (Zurn) Model DU series dielectric unions with EPDM dielectric gasket, 250 psi at 180°F.

B. 2-1/2” through 4”:

1. Watts dielectric flange fittings Series LF 3100/LF 3110 with dielectric gasket, 175 psi at 180°F.
2. Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used in lieu of dielectric unions for pipe sizes 2-1/2” and larger.
   a. Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig.

2.9 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL TO STEEL PIPE)

A. Similar to Epco model W with bolt insulators, dielectric gasket, bolts and nuts, 175 psi at 210°F. Pikotek model VSC dielectric gasket with viton sealing element, G-10 sleeve and double washers, suitable to 350°F, may be used with specified flanges.

2.10 THREADED JOINT SEALANTS

A. Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50°F to 400°F and up to 10,000 psi (liquids) and 2000 psi (gases), certified by UL, CSA, and NSF.

B. Use sealant similar to Loctite Model 54531 for piping handling oil or petroleum products.

2.11 WELD BRANCH OUTLET FITTINGS (WELDOLETS, THREADOLETS AND SOCKOLETS)

A. Weld branch outlet fittings shall conform to MSS-SP-97, ASME B16.9 for weldolets, ASME B1.20.1 for threadolets and ASME B16.11 for sockolets.

B. Materials shall match material of header piping and wall thickness of outlet or branch end shall match wall thickness of branch pipe.

2.12 MECHANICAL GROOVED PIPE CONNECTIONS

A. Mechanical grooved pipe coupling system including elbow, tee and reducer fittings, as manufactured by **[Victaulic] [Victaulic or Anvil Gruvlok]** may be used in lieu of flanged or welded steel piping 2-1/2" and larger for systems and spaces indicated below.

B. The following services may use mechanical grooved pipe connections within limitations indicated.

1. Chilled Water
2. Condenser Water
3. Cooling Coil Condensate Drain
4. Heating Hot Water

C. Mechanical grooved pipe connections may be used in spaces indicated below.

1. Mechanical equipment spaces
2. Accessible spaces including ceiling spaces above occupied areas

D. Mechanical grooved pipe connection shall not be used in non-accessible spaces such as chases or above critical spaces such as ORs and data centers.

E. Grooved pipe connection system materials used for the Project shall be produced by the same manufacturer.

F. Couplings shall be equal to Victaulic 07, 107, or W07 ridged couplings. However, three (3) Victaulic 77, 177, or W77 flexible couplings in close proximity to pump connection (except in-line pumps) may be used in lieu of flexible connectors required in Section 23 0550 - Vibration Isolation.

G. Victaulic Style 107 QuickVic rigid couplings with EHP gaskets may be used.

H. Grooved fittings, and specialties manufactured by coupling manufacturer will be acceptable, provided it meets requirements specified in this Section.

I. Acceptable materials are listed below, based on Victaulic. When used on galvanized piping, fittings and couplings shall be galvanized in accordance with ASTM A153 Hot Dip Galvanizing. When used on black steel piping, fittings and couplings shall have enamel coating. Fittings and couplings must be suitable for temperature and pressure involved.

J. Refer to Section 23 2118 – Valves for grooved connection valve requirements.

K. Couplings:

1. Ductile iron, ASTM A-536, Grade 65-45-12, Style 07, 107, or W07 Zero-flex rigid couplings, complete with housings cast with offsetting, angle-pattern bolt pads, used to provide system rigidity and support and hanging in accordance with ASME B31.1.
2. Ductile iron, Style 77, 177, or W77 flexible couplings for use in locations where flexible connectors are required.

L. Flanges:

1. Ductile iron Style 741 or 743.

M. Fittings:

1. Ductile iron elbows and tees of manufacturer's standard line may be used in all sizes except bullhead tees will not be accepted. Fittings shall be full-flow fittings. Mechanical tee Style 920 or 920N fittings with ductile iron housings may be used for up to 4" outlet size.
2. Ductile iron fittings shall conform to ASTM A-536.

N. Gaskets:

1. Gaskets shall be elastomer grade suitable for intended service, and shall be molded and produced by coupling manufacturer.
2. Grade "E" EPDM compound, ASTM D-2000, suitable for temperature from -30°F to 230°F.

O. Hot water heating system shall use "EHP" EPDM, ASTM D-2000, flushseal gaskets, suitable for temperature from -30°F to 250°F.

P. Bolts and Nuts:

1. Heat treated carbon steel, track head conforming to ASTM A-183 zinc electroplated, minimum tensile 110,000 psi zinc electroplated.

Q. Expansion Joints:

1. Credit for inherent flexibility of mechanical grooved pipe connections when used for expansion joints, may be allowed upon specific application by Contractor. Request shall be made in writing and shall include service, location, line size, proposed application and supporting calculations for intended service.

2.13 REFRIGERANT PIPING

A. ASTM B88 Type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR" with ANSI B16.22 wrought copper or forged brass solder-type fittings.

PART 3 - EXECUTION

3.1 GENERAL

A. Remove foreign materials before erection. Ream ends of piping to remove burrs.

B. Install piping parallel to building walls and ceilings and at such heights so as not to obstruct any portion of window, doorway, stairway, or passageway. Install piping to allow adequate service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical piping plumb. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.

C. Mitered elbows, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.

D. Unless otherwise indicated, use fittings as specified in Part 2 of this Section for elbows, tees, reducers, etc.

E. "Weldolets" with outlet size 2-1/2” and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for branch connections up to one pipe size smaller than main. Use "Threadolets" where threaded fittings are specified and use "Sockolets" where socket weld fittings are specified. Install in accordance with PFI (Pipe Fabrication Institute) Standard ES49.

F. Install drains throughout systems to permit complete drainage of entire system.

G. Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.

H. Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed.

I. Make connections to equipment installed by others where that equipment requires piping services indicated in this Section.

J. For piping within the scope of ASME B31.1 Power Piping, transfer piping material specification and "Heat Number" to each segment of pipe prior to cutting.

3.2 THREADED PIPE JOINTS

A. Threads of pipe and fittings shall conform to ASME B1.20.1.

B. Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.3 FLANGED JOINTS

A. Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.

B. Position gasket concentrically so compression is equally distributed over entire gasket surface.

C. Lubricate bolts and run nuts down by hand.

D. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.

E. Re-torque bolts 12 to 24 h after start up.

3.4 WELDED PIPE JOINTS

A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.

C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 50°F before welding.

D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.

E. Use weld material diameter as procedurally required for type and thickness of work being done.

F. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus 5 seconds. Maintain purge for at least 2 layers of weld material.

G. Properly store welding materials.

H. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.

I. Weld reinforcement shall not exceed limits established in Chapter V of ASME B31.1.

J. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.

3.5 COPPER PIPE JOINTS

A. Cutting of tubing shall not make tubing out of round. Ream cut tube ends to full inside diameter.

B. Remove slivers and burrs remaining from tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for specific piping service.

C. Press Joint Option:

1. Cut pipe square and ream before assembly
2. Insert pipe fully into fitting and mark on pipe at shoulder of fitting
3. Check fitting alignment against mark on pipe to ensure pipe is fully engaged
4. Press joint with press tool approved by fitting manufacturer

3.6 WATER SYSTEMS

A. Unless otherwise indicated, install horizontal piping level. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

B. Main branches and runouts to terminal equipment may be made at top, top 45°, side or bottom 45° of main provided that there are drain valves suitably located for complete system drainage and manual air vents are located as described above.

C. Unless otherwise indicated, use top or top 45° connection to main for upfeed risers, and use side or bottom 45° connection to main for downfeed risers. Bottom connection is not allowed.

D. Use minimum of 3 elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems. Offset pipe connections at equipment to allow for service, such as removal of terminal device.

E. Unless otherwise indicated, use concentric fittings for changes in pipe sizes and for valves smaller than pipe sizes.

F. Notch and dimple branch tubes. Braze joints. Apply heat properly so that pipe and tee do not distort. Remove distorted connections.

G. Where mechanically formed tee fittings are allowed, form mechanically extracted collars in continuous operation, consisting of drilling pilot hole and drawing out tube surface to form collar having height of not less than 3 times thickness of tube wall. Collaring device to be adjustable.

3.7 RAW WATER MAKE-UP

A. Refer to Section 22 1118 - Water Distribution System

B. Install piping where indicated, including valves, piping specialties and dielectric unions required for functional system.

C. Raw water make-up piping for this Section is defined as fill line containing pressure reducing valve for water systems.

3.8 CHEMICAL TREATMENT

A. Install piping as indicated on drawings, as detailed, and as recommended by supplier of chemical treatment equipment.

3.9 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on drawings, as detailed, and as specified for each specific valve or piping specialty item.

3.10 COOLING COIL CONDENSATE DRAIN

A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

B. Pitch pipe down at 1/4" per one foot for proper drainage.

C. Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

3.11 DIELECTRIC UNIONS AND FITTINGS

A. Install dielectric unions, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric unions or fittings shall not be used at terminal device connections.

B. Concealed dielectric unions and fittings are not allowed.

C. Install steel to steel pipe dielectric unions or flanges in chilled water piping at each point where interior steel piping is connected to exterior underground steel piping.

3.12 UNIONS AND FLANGES

A. Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.

B. Concealed unions or flanges are not allowed.

3.13 MECHANICAL GROOVED PIPE CONNECTIONS

A. Install grooved joints in accordance with manufacturer’s latest published installation instructions.

B. Use pipe factory grooved in accordance with coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for application.

C. Grooved couplings, gaskets, fittings, valves, specialties, and grooving tools shall be provided from the same manufacturer.

D. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedure in accordance with manufacturer's recommendations.

E. Lubricate pipe and coupling gasket, align pipe and secure joint in accordance with coupling manufacturer's specifications.

F. Support pipe as indicated in Mechanical Supporting Devices section of these specifications except as modified below. Support each horizontal pipe section at least once between couplings and whenever change in flow direction takes place. Support vertical pipe at every other floor or every other pipe length, whichever is most frequent. Set base of riser or base fitting on pedestal or foundation.

G. Grooved coupling manufacturer’s factory trained representative shall conduct on-site training for Contractor's field personnel in installation of grooved products and proper use of grooved tools. Grooved manufacturer's representative shall submit written documentation to verify completion of required training.

H. Factory-trained representative shall periodically visit jobsite after initial tool and installation training and review field grooving procedures and product installation to insure installation guidelines are being followed.

I. Contractor shall remove and replace any improperly installed products.

J. Factory-trained field representative shall provide additional training to Contractor to mitigate any further improperly installed products.

3.14 REFRIGERANT PIPING

A. Install refrigerant piping system to meet requirements of Wisconsin Department of Industry, Labor and Human Relations Refrigeration Code.

B. Solder joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1250°F. Solder impurities shall not exceed 0.15%. Tubing shall be new and delivered to job site with original mill end caps in place. Clean and polish joints before soldering. Avoid prolonged heating and burning during soldering. Purge pipes with nitrogen during soldering. Provide manual shut-off and check valves as required.

C. Leak test by charging system to pressure of 10 psig with the same type of refrigerant that will be used in the system.

D. Charge refrigerant into system through Sporlan catchall filter-drier. Finally increase pressure to 300 psig with oil pumped dry nitrogen. Rap joints with rubber or rawhide mallet and check for leaks with electric leak detector having certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

E. After completion of leak test, evacuate system with vacuum pump to 2.5 mm Hg absolute as measured on accurate gauge.

F. System ambient temperature shall be above 60°F during evacuation, charge refrigerant into system to 0 psig, then repeat evacuation to 2.5 mm Hg absolute. Allow system to stand evacuated for at least 12 h. If no noticeable rise in pressure occurs, system may be charged.

G. Charge system with new refrigerant through charging valve and filter-drier. Continue charging until bubbles disappear from liquid line sight glass while compressor is in operation.

H. Refrigeration piping must be installed by firms who are experienced in installation of such piping.

3.15 PIPING SYSTEM PRESSURE TESTS

A. Owner and/or Owner's representative may elect to witness pressure test. Notify Owner and/or Owner's representative at least 3 days in advance.

B. Conduct pressure test prior to flushing and cleaning of piping systems.

C. Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed below.

D. If leaks are found, repair with new materials and repeat test until leaks are eliminated. Caulking will not be acceptable.

E. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

F. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 h plus such additional time as may be necessary to conduct examination for leakage.

G. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

H. Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

I. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

J. Conduct pressure tests with parameters indicated below:

System	Minimum Test Pressure	Remarks
Heating hot water	100 psig	HYDRO
Chilled water	100 psig	HYDRO

K. Contractor shall provide all pumps, gauges, instruments; test equipment, flow meters, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

L. If piping system is drained after testing and left empty or untreated for more than 3 days, add Nalco 2572 at recommended dosages for dry system lay-up.

3.16 FLUSHING AND CLEANING PIPING SYSTEMS

A. Notify Owner and/or Owner's representative at least 7 days in advance.

B. Flush new water, fluid, steam and condensate systems thoroughly for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system. Bypass pumps and equipment and remove strainers from strainer bodies. Provide circulation by Contractor-supplied portable pumping apparatus.

C. Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory-cleaned equipment, and any component that may be damaged.

D. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers.

E. After initial flushing of system, use portable pumping apparatus to circulate cold water detergent for water systems. Refer to Section 23 2514 - Chemical Treatment Systems for pipe cleaning.

F. After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

G. Refer to Section 23 2514 - Chemical Treatment Systems for water analysis.

3.17 INITIAL SYSTEM FILL AND VENT

A. Fill and vent systems with proper working fluids.

B. Use fluids chemically treated as specified in Section 23 2514 - Chemical Treatment Systems.

C. Glycol system shall be filled with treated glycol as specified in Section 23 2514 - Chemical Treatment Systems.

END OF SECTION 232116

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SECTION 232118 - VALVES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 22 1600 - Natural Gas Piping

C. Section 23 0902 - Control Valves and Dampers

D. Section 23 2120 - Piping Specialties (Flow Sensors and Meters)

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings for each system for all sizes including, but not limited to, the following:

1. Name of system
2. Manufacturer's name
3. Type
4. Model number
5. Materials of construction
6. Temperature/pressure ratings
7. Manufacturer's data sheets clearly cross-referenced
8. All other appropriate data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gate valves, globe valves, check valves, and drain valves: Crane, Nibco, Stockham, Powell, Milwaukee, Hammond, or Grinnell equal to manufacturer's Figure number listed. Provide valves of same make for these services.

B. Other valves: acceptable manufacturers and Figure Number listed under each item.

C. Butterfly valves and check valves manufactured by grooved coupling manufacturer will be acceptable where grooved pipe connection system is allowed, provided valves meet requirements specified in this section.

2.2 WATER SYSTEM VALVES

A. General:

1. Valves 2" and smaller in steel piping shall have threaded ends.
2. Valves 2" and smaller in copper piping shall have solder ends.
3. Press Ends:
   a. Valves with press ends will be acceptable where press joints are allowed, provided valves meet requirements specified in this section. Temperature and pressure ratings shall be equal to or exceed ratings of press fittings used.

4. Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.

B. Ball Valves:

1. 2" and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4" and smaller and conventional port for 1” and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi WOG, 150 psi SWP, Nibco Fig. T(S)-580-70, Apollo No. 70, Watts, Milwaukee BA-150, Hammond, FNW or Anvil
2. 2" and Smaller: ASTM B584 bronze body, threaded, stainless steel ball and stem, full port, Teflon seat rings, blowout-proof stem, 3-piece construction, 600 psi WOG, 150 psi SWP, Nibco Figure T(S)-595, Apollo, Watts, Hammond, Grinnell, Kitz or Milwaukee

C. Spring Loaded Check Valves:

1. 2" and Smaller: bronze or iron body, Class 125 (200 psi WOG), Nibco Figure T(S)-480, Mueller Figure 303-AP or Metraflex No. 700
2. 2-1/2" and Larger: cast iron or ductile iron body, flanged or wafer type, 302/304 or 316 stainless steel spring, aluminum bronze, carbon steel or ductile iron totally encapsulated in EPDM disc, Buna-N or electroless nickel plated seat, Class 125 (200 psi WOG), Nibco Figure F-910 or W-910, Milwaukee 1800 or 1400, Metraflex No. 700, Stockham Figure WG-970, Mueller Sure Check Model No. 71, or Crane Duo-check II
3. Victaulic series 716 or 779 with grooved end will be acceptable where grooved pipe connection system is allowed.
4. For valves 8” and larger, provide lifting lugs or threaded holes for lifting eye bolts.

D. Shut-Off Valves:

1. 2" and Smaller: ball valves as specified in this Section
2. 2-1/2" and Larger: butterfly valves as specified in this Section

E. Balancing Valves:

1. 2" and Smaller: calibrated balancing valves:
   a. Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710, or fixed orifice with ball valve type as manufactured by IMI Flow Design, Hays, Nexus, HCi or Taco. Bronze or brass body, 250 psi Maximum Allowable Working Pressure, 250°F Maximum Allowable Operating Temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.
   b. Valves shall measure down to 0.3 gpm with accuracy of ±5%.

c. Valves shall be leak-tight at full rated working pressure.
d. Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.

2. 2-1/2" and Larger: Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788/789, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi Maximum Allowable Working Pressure (MAWP), 250°F maximum operating temperature. Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi maximum working pressure, 250°F maximum operating temperature will be acceptable up to 4" size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in Section 23 2120 - Piping Specialties, under Flow Sensors and Meters may be used when sizes for Armstrong or T/A valves are not available. Locate flow sensor in common pump discharge pipe with hot tap. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.
3. Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature, 300 psi working pressure. Meter accuracy shall be ± 2% full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.
4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

F. Terminal Unit Valve Assembly

1. Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements.
2. Victaulic, Nexus, Griswold, HCi, IMI Flow Design or Hays are acceptable.
3. Inlet Assembly: combination of isolation ball valve, y-strainer with 20 mesh SS screen and blowdown valve, union, and PT test port.
4. Outlet Assembly: Union assembly consisting of union, manual air vent and PT test port at coil outlet (control valve inlet) and ball valve, union, PT test ports and balancing valve at control valve outlet. Balancing valves shall be as specified under Balancing Valves in this Section.
5. Components: Assembly shall have minimum pressure/temperature ratings to 400 psi/ 230°F.
6. Flexible Hose:
   a. Flexible hoses up to 18” in length may be used in inlet and outlet assemblies for 1” and smaller.
      1). EPDM Core:
         a). Flexible hose shall be constructed of EPDM core, stainless steel braided cover, stainless steel ferrules, and brass end connections. Maximum Allowable Operating Pressure (MAOP) shall be not less than 300 psi at 230°F.
      2). Stainless Steel (Corrugated) Core:
         a). Flexible hose shall be constructed of corrugated 300 series stainless steel core, 300 series stainless steel braided cover, stainless steel ferrules, and 304 stainless steel end connections. Maximum Allowable Operating Pressure (MAOP) shall be not less than 400 psi) at 600°F.

G. Butterfly Valves:

1. 2-1/2" and Larger:

a. Manufacturers: DeZurik, Keystone, Nibco, Milwaukee, or Bray
b. Ductile iron body, stainless steel shaft, aluminum-bronze disc, or Nylon 11 coated ductile iron disc, upper thrust bearing, EPDM resilient seat, rated at 200 psi bidirectional shut-off pressure , suitable for continuous operation at temperature up to 225°F, compatible to ANSI B16.1 Class 125/150 flange standards, conforming to MSS-SP-67.
c. Dead end pressure rating shall be 150 psi with no downstream flange/piping attached.
d. For valves 6" and smaller, provide 10-position lever actuators with locking devices. For valves 8" and larger, provide worm gear operators with adjustable position stop and position indicators. Size hand wheel operators with no higher than 80 lb rim pull at full valve pressure rating.
e. External disc-to-stem connections using screws or pins are not allowed.
f. Valve necks shall be of sufficient length to allow for insulation where insulation is specified. Wheel shaft shall be sufficient length so wheel does not touch insulation.
g. Provide full lug type valves permitting removal of down stream piping while using valve for system shut-off.
h. Furnish valves used for balancing with adjustable memory stops.

H. Valves Located Underground or in a Vault Shall Be High Performance Butterfly Valves:

1. Manufacturers: DeZurik Type BHP, Xomox, Jamesbury, Bray Series 40, or Posi-Seal

2. Gear-operated with square nut drive, stainless steel or carbon steel body, ANSI Class 150 design, bidirectional bubble-tight shut off at 275 psi, threaded lug type, upper and lower body bearings with thrust bearings, one piece single or double offset shaft of 316 stainless steel and centerless ground and polished to minimize bearing and packing wear, PTFE seats, PTFE adjustable V-ring packing, capable of service in temperature ranges of -100 to 300°F, 316 stainless steel discs and totally enclosed, factory lubed, rotary actuator.
3. Dead end pressure rating shall be 275 psi without downstream flanging.

I. Water Pressure Regulating Valves:

1. Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G
2. Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for Maximum Allowable Working Pressure (MAWP) of 125 psig and Maximum Allowable Operating Temperature (MAWT) of 160°F.

J. Lockshield Valves:

1. Ball valves as specified above with locking handles for padlocking tin open or closed position.

K. Drain Valves:

1. Ball valve as specified above with threaded hose adapter and cap. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

2.3 WATER PRESSURE RELIEF VALVES

A. Valves shall have ASME “UV” or “V” stamp.

B. Manufacturers: Kunkle, Consolidated, Thrush, Watts, Cash-Acme, Keckley, or B & G. Iron or bronze body, direct pressure actuated, non-metallic seat, stainless steel stem and spring, and suitable for Maximum Allowable Working Pressure (MAWP) of 125 psig at 240°F.

C. Valves shall meet applicable State and local Code requirements for unfired pressure vessels.

D. Valves shall have ASME “UV” or “V” stamp.

2.4 GAUGE VALVES

A. Unless otherwise indicated, gauge valves for steam, steam condensate and feedwater services shall be gate valves specified under applicable pressure-temperature range. Gauge valves for all other services shall be needle valves, brass body, with pressure and temperature rating appropriate for application. Minimum pressure-temperature rating shall be 600 psig at 300°F. Gauge valve size shall match pressure gauge connection size as specified in Section 23 2120 – Piping Specialties.

B. Ball valves meeting valve specification for applicable piping system may be used.

2.5 CHAIN WHEEL OPERATORS

A. Similar to Babbitt cast iron or ductile iron adjustable sprocket rims and chain guides. Use galvanized or brass chain and chain closure links to form continuous loop of chain at each operator.

PART 3 - EXECUTION

3.1 GENERAL

A. Install valves as shown on plans, details and according to manufacturer's installation recommendations.

B. After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

C. Install control valves furnished under Control Systems. Provide reducing fittings as required.

D. Refer to Section 23 2116, Part 3 for reducing fittings requirement for valves smaller than pipe size.

E. Provide chain operators for manually operated valves furnished with gear operators, which are located more than 8 ft above equipment room floor.

3.2 SHUT-OFF VALVES

A. Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.

3.3 BALANCING VALVES

A. Provide balancing valves where indicated on drawings and as required for complete balancing of water systems.

B. Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

C. Balancing valve at pump discharge line is not required where pump is driven by variable frequency drive (VFD).

3.4 GAUGE VALVES

A. Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.5 DRAIN VALVES

A. Provide drain valves at all low points of piping systems for complete drainage of systems.

B. Unless otherwise indicated, provide 1/2" drain valve for 1/2" piping and minimum 3/4" drain valve for 3/4" and larger piping, except strainer blowdown valves shall be blowdown connection size.

3.6 WATER PRESSURE REGULATING VALVES

A. Set valves for pressure required or as scheduled.

3.7 WATER RELIEF VALVES

A. Unless otherwise indicated, provide one relief valve in each closed water system in the pump inlet piping.

B. Locate liquid pressure relief valve on pump suction side between expansion tank and pump.

C. Install valve in accordance with manufacturer’s instructions.

D. Unless otherwise indicated, pipe discharge to within 8" of floor with outlet of discharge pipe pointing down.

3.8 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.9 SWING CHECK VALVES

A. Install check valves in horizontal piping.

END OF SECTION 232118

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SECTION 232120 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0594 - Water Systems Test Adjust Balance

B. Section 23 0903 - Control Instrumentation (Temperature and Pressure Sensing Requirements)

C. Section 23 2118 - Valves

1.2 [REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.]**

1.3 REFERENCE STANDARDS

A. Metal bellows expansion joints shall be constructed and applied in accordance with "Standards of the Expansion Joint Manufacturer's Association", 8th Edition, 2003.

1.4 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the Documents
3. Materials of construction
4. Dimensional data
5. Capacities/ranges
6. Temperature/pressure ratings
7. Pressure drop
8. Expansion joint schedule indicating joint tag no., system, proximity to rotating or reciprocating equipment, required movement in all planes, service pressure, test pressure, service temperature, fluid velocity and cycles to failure (both thermally and seismically, if applicable).
9. All other appropriate data.

B. LEED Submittal

1. Product Data for IEQ Credit 4.1: For adhesives and sealants, including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, select devices for highest pressures and temperatures existing in respective systems in accordance with ANSI Specifications.

B. Piping specialties in copper piping shall have bronze or brass body with solder ends.

2.2 THERMOMETERS

A. Manufacturers: Taylor, Trerice, Weksler, Miljoco, Winters, or Weiss

B. Pipeline mounted thermometers: 9" scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with mercury free indicating fluid, adjustable angle stem, extended neck suitable for insulated piping as required, and compatible with sockets as specified herein.

C. Panel or remote mounted thermometers: vapor actuated dial type with remote bulb, 4-1/2" minimum diameter cast metal casing with double front. Sensing bulbs shall be of length to suit pipe diameter with extended necks as required for insulated piping, suitable for insertion in separable brass sockets as specified herein.

D. Duct type thermometers: dial type with minimum dial size of 4-1/2" and maximum graduations of 2°F, complete with swivel mounting arrangement to permit up to 45° rotation for easy reading.

E. Range of thermometer for particular installation shall extend from point at least 40°F below lowest point of equipment's or system's operating range to point at least 40°F above highest point of that range.

F. Range of thermometers shall be:

Service	Scale Range	Increment
Chilled Water	0°F to 100°F	1°F
Condenser Water	30°F to 130°F	1°F
Heating Hot Water	30°F to 240°F	2°F
Steam Condensate	30°F to 300°F	2°F
Air (indoor)	0°F to 160°F	2°F
Air (outdoor)	(-40°F to 100°F)	2°F

G. Thermometers by temperature control manufacturer meeting above Specification will be acceptable.

2.3 THERMOWELLS AND TEST WELLS

A. Brass construction with threaded connections suitable for thermometer stems or bulbs and temperature control sensing elements, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. For test well, furnish with brass cap and short chain to secure cap to body.

B. Stainless steel construction for stainless steel piping.

2.4 PRESSURE GAUGES

A. Manufacturers: Ashcroft, U.S. Gauge, Marsh, Trerice, Miljoco, Marshalltown, Weksler, Winters or Weiss equal to Trerice 600 Series

B. Minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket.

C. Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1% full scale).

D. Select gauge range so that normal operating pressure is at midpoint of gauge.

E. Reading range of gauges shall be:

Service	Scale Range
Chilled Water	0 to 100 psig
Heating Hot Water	0 to 100 psig

F. Pressure Snubbers:

1. 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings, 1000 psig WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

2.5 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plugs made by Peterson Equipment Company, Sisco, Super Seal by Flow Design Inc. (FDI), or approved equal.

B. Test plugs shall be 1/4" or 1/2" NPT, brass body and cap, 1-1/2" length for non-insulated pipe and 3" length for insulated pipe, with Nordel self-closing valve cores, rated at 500 psig at 275°F, and shall receive either temperature or pressure probe with 1/8" OD.

C. Furnish portable test kit within durable case containing the following:

1. A compound pressure gauge,3-1/2" dial, 30" Hg – 100 psi, field calibration screw, surge protector and stainless steel gauge adapter with 1/8" diameter probe (2% accuracy of mid range).
2. Two pocket testing thermometers, 1-3/4" dial, 5" long stainless steel stem, 0 - 220°F and 25 - 125°F ranges with external calibration (1% accuracy of entire scale).

2.6 PIPE EXPANSION DEVICES

A. Flexible Expansion Loops (Thermal Expansion):

1. Manufacturers: Metraflex or Twin City Hose
2. Flexible expansion loops shall be Metraflex Metraloop consisting of 2 flexible sections of hose and braid, two 90° elbows, and a 180° return, with factory supplied, center support nut located at bottom of 180° return and drain/air release plug.
3. Flexible loops shall impart no thrust loads to system support anchors or building structure.
4. Unless otherwise indicated, material of construction, end fitting type and pressure ratings shall be consistent with pipe material, pipe connection fittings and pressure rating as specified in specification Section 23 2116 - Pipe and Pipe Fittings.
5. Hose and braid material shall be 316L.

2.7 PIPELINE STRAINERS

A. Manufacturers: Metraflex, Mueller Steam Specialty, Nibco, Hoffman, Eaton (formally Hayward), Sarco, Keckley, Armstrong, Wheatley, Conbraco, Titan, or Streamflo

B. Liquid System:

1. 2" and Smaller: full pipeline size, Y-type, with removable screen caps, cast iron, Class 250 (400 psi/150°F WOG), threaded ends for carbon steel piping and cast bronze, Class 125 (200 psi/150°F WOG), solder ends for copper piping. Screen caps shall have threaded blowdown connection.
2. 2-1/2" and Larger: full pipeline size, Y-type, Class 125(200 psi/150°F WOG), cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.
3. Strainers manufactured by grooved coupling manufacturer will be acceptable where grooved pipe connection system is allowed.
4. Liquid Service Screens: stainless steel with screen perforation as indicated below. For strainers serving equipment where manufacturer requires specific screen perforation, provide per manufacturer requirements. Maximum pressure drop shall be 4 ft WG through clean strainer.

Pipe Size	Closed System	Open System
2" and smaller	1/32" (20 mesh)	1/8"
2-1/2" to 4”	1/16”	1/8"
5" and over	1/8"	1/8"

2.8 EXPANSION TANKS

A. Manufacturers: Amtrol, Taco, Bell and Gossett, Armstrong, Wheatley, or Wessels

B. Tanks shall be replaceable bladder type air pre-charged to initial fill pressure as scheduled. Furnish tank suitable for 125 psig WP, constructed, tested and stamped in accordance with ASME Code, and sealed-in elastomer bladder suitable for operating temperature of 240°F. Bladder shall be compatible with water and with ethylene and propylene glycol. Furnish mounting saddles for horizontal tanks and mounting base for vertical tanks. Furnish tanks with system connections; drain connections for floor-mounted tanks, and air charging valves.

2.9 AIR SEPARATORS

A. Manufacturers: Bell and Gossett, Amtrol, Armstrong or Taco

B. 1-1/2” and Smaller: Cast iron construction with steel diffuser tube, bottom and side threaded inlet connections, bottom and top threaded outlet connections, threaded top connection for air elimination, designed for maximum 125 psig WP.

C. 2” and Larger:

1. Centrifugal type, cast iron or carbon steel construction, flanged connection, threaded connections acceptable for 3” and smaller, perforated stainless steel air collector tube to direct air toward air elimination connection at top of unit, inlet and outlet connections tangential to vessel shell, bottom blow down connections, constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code for 125 psig design pressure at 350°F.
2. Vessel shell diameter shall be at least 3 times nominal inlet/outlet pipe diameter.
3. Manufacturer’s data sheet shall include air collection efficiency and pressure drop at design flow scheduled.

D. Where integral strainer is indicated on air separator schedule, furnish with removable galvanized steel system strainer with 3/16” diameter perforations and free area not less than five times cross sectional area of connecting pipe.

2.10 AIR AND DIRT SEPARATORS

A. Manufacturers: Spirovent or approved equal. Eliminators by Caleffi and Wessels will be acceptable, provided units meet the specified requirements.

B. Coalescing type combination air and dirt separator, designed for maximum 150 psig WP, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. Connections 2” and larger shall be flanged. Smaller connections may be flanged or threaded. Inlet size shall be no smaller than scheduled size. Inlet velocity shall be 4.0 feet per second or less, except where model VHN or VHR is indicated, velocity may be in the range of 4.0 to 10.0 feet per second.

C. Coalescing medium shall consist of copper core tube with continuous wound copper wire permanently attached and followed by a separate continuous wound copper wire permanently affixed or stainless steel. Submittal shall show that medium fills the entire vessel above and below relatively smaller chambers for dirt collection and venting, respectively. Partial fill is not acceptable.

D. Air elimination efficiency shall be 100% of free air, 100% of entrained air, and 99.6% of dissolved air.

E. Dirt separation efficiency shall be 80% of particles 30 microns and larger within 100 passes.

F. Venting chamber shall be provided with integral full port float actuated brass venting mechanism.

G. Unit shall include valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

H. Drain valve at bottom of unit for flushing/dirt removal, 1” for units size 12” and smaller, 2” for units size 14” and above.

2.11 PUMP SUCTION DIFFUSERS

A. Manufacturers: Bell & Gossett, Armstrong, Mueller Steam Specialty, Wheatley or Taco

B. Cast iron or ductile iron body with angle pattern flow straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16” diameter openings, 175 psig WP, at 250°F. Threaded ends for 2” and smaller and flanged ends for 2-1/2” and larger. Orifice cylinder shall have free area of at least 5 times cross section area of pump suction opening. Furnish each unit with disposable fine mesh start-up strainers, gauge tappings, blow down connection, and adjustable support foot to carry weight of suction piping.

C. Pump suction diffusers manufactured by grooved coupling manufacturer will be acceptable where grooved pipe connection system is allowed.

2.12 AIR VENTS

A. Manual Air Vents:

1. Manufacturers: Bell & Gossett Model 4V, 125 psig at 210°F or approved equal. Use 1/2" ball valve for main pipes.

B. Automatic Air Vents:

1. Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman
2. Metal construction, non-corrosive working parts, 150 psig WP at 240°F
3. Normal capacity vent shall be similar to B&G Model 87
4. High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig, similar to B&G Model 107A.

2.13 FLOW ELEMENTS (MEASURING STATIONS) AND METERS

A. Averaging Pitot Tube Flow Elements (2-1/2" and Larger):

1. Manufacturers: Dieterich Standard, or Preso
2. Elements shall be averaging differential pressure type consisting of sensing tube with 2 internal chambers; one for sensing upstream pressure and one for sensing downstream pressure.
3. Furnish each flow measuring station complete with safety shut-off valves, quick coupling connections and permanent metal tag showing designed flow rates, meter readings for designed flow rates, metered fluid, line size and tag, station or location number. Annular measuring element shall be constructed of stainless steel. Stations shall be nipple section or weld insert type and be rated to 250 psi at 250°F.
4. Hot tap type flow stations shall include isolation valve and packing gland retraction assembly. Connection shall be flange type. Station shall be rated to 250 psi at 250°F.
5. Portable differential pressure meter set shall be of totally dry single diaphragm type with min. 4-1/2" dial pointer indicator, 0" to 50" WG reading range, accuracy of ± 3.0% full scale, and wetted metal parts of brass or stainless steel. Meter shall include variable pulsation dampening control, integral equalizing valve, and 2 bleed valves.
6. Furnish meter set complete with master chart for direct conversion of meter readings to gpm rust proof carrying case, two minimum 10 ft rubber test hoses, with brass valves for quick connections to flow sensor. Meter shall become property of Owner.
7. Furnish elbow mounted Pitot tube measuring stations at locations where manufacturer's recommended straight pipe lengths are not available for straight pipe mounted measuring stations.

B. Venturi Flow Elements:

1. Manufacturers: Hyspan, Gerand, or Preso
2. Elements shall be flanged ends for 2-1/2" and larger and threaded ends 2" and smaller. Furnish tubes with quick disconnect taps and shut off valves, suitable for 125 psig WP. Select tubes for size and pressure drop as scheduled and tag for mark number, flow and pressure drop as specified.
3. Provide portable meter kit within durable case. Furnish with 6" diameter forged brass meter having dial range from 0" to 50" WG. Provide in kit equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.
4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

C. Orifice Plate Flow Elements:

1. Daniel or Precision Flow Products, factory calibrated bores and companion flanges complete with pressure taps, bolts, nuts, gaskets and jack screws. Furnish element with threaded connections for piping 2” and smaller and butt welded necks for 2-1/2” and larger. Furnish pressure tappings with quick disconnect taps and shut-off valves, suitable for 125 psig WP. Select orifice plates for size and pressure drop as scheduled and tagged for mark number, flow and pressure drop as specified.
2. Furnish portable meter kit with durable case with 6” diameter forged brass meter having dial range from 0” to 50” WG. Furnish in kit, equalizing valves, vent hose and size devices specified. Meter shall become property of Owner.
3. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

2.14 STRAIGHTENING VANES

A. Manufacturers: Daniel Industries, Inc., Houston, Texas or approved equal

B. Straightening vane assembly shall consist of series of carbon steel pipes firmly welded together and to line size pipe. Furnish vanes with class 150 psi flanges for insertion into piping system.

2.15 WATER FILTERS

A. Manufacturers: Pall Corporation, Ronningen-Petter, Graver Technologies (Consler), FSI, Filterite or Parker Hannifin

B. Housing shall be constructed of carbon steel for 150 psi WP, constructed in accordance with ASME Code, painted with manufacturer’s standard paint.

C. Filter access shall be with bolted and gasketed steel or cast iron head.

D. Pipe connection shall be threaded for 2” and smaller, and flanged for 2-1/2” and larger.

E. Cartridge Filter Media:

1. Construct filter cartridges of disposable media with minimum media area of 4-1/2 sq ft per cell.
2. Cartridges shall be capable of proper operation at pressure differentials up to 35 psid and temperature to 230°F.
3. Furnish 3 sets of filter cartridges, 2 sets capable of removing 95% of solid particles 10 microns or larger and one set capable of removing 95% of solid particles 50 microns or larger. Use 50 microns filters at initial start-up. When loaded up, replace with 5 microns filters.
4. To insure against by passing, provide positive seal on each cartridge stack consisting of internal tie rod and seal nut arrangement, or equivalent. Single continuous cartridge per stack to be used.

F. Bag Filter Media

1. Disposable type bag filters may be used in lieu of cartridge filters. Filter media to be capable of proper operation at pressure differentials up to 35 psid and temperature to 230°F.
2. Furnish 3 sets of filter media, 2 capable of removing 95% of solid particles 10 microns or larger and one capable of removing 95% of solid particles 75 microns or larger.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties as indicated on plans, details and according to manufacturer's recommendations.

3.2 THERMOMETERS

A. Install thermometers in thermowells in locations indicated.

3.3 THERMOMETER TEST WELLS

A. Install test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

3.4 PRESSURE GAUGES

A. Install gauges for services other than steam with pressure snubbers and gauge valves.

3.5 PRESSURE GAUGE TAPPING

A. Install tappings with gauge valves at each point where sensing device is required under Control Systems and at gauge locations as shown.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.6 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.7 PIPE EXPANSION DEVICES

A. Stretching of expansion joints or connectors to correct for piping misalignment is not allowed.

B. Install expansion loops, L-bends, Z-bends, and compensators where shown on drawings and as necessary to allow expansion and contraction in piping systems.

C. Flexible Expansion Loops:

1. Install loops in neutral or pre-extend condition as required for application. For steam service, install loops with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations.

3.8 PIPELINE STRAINERS

A. Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.

B. Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

3.9 AIR SEPARATORS

A. Provide valved blow down connections and extend drain piping to nearest floor drain.

3.10 PUMP SUCTION DIFFUSERS

A. Pipe blow down to the nearest floor drain with drain valve at unit.

B. Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

3.11 AIR VENTS

A. Install manual air vents at all high points in water systems where air may collect and where shown on drawings.

B. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain.

C. Install high capacity automatic air vent at air separator.

3.12 FLOW ELEMENTS/FLOWMETERS

A. Flow elements/flowmeters located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.

B. If flow elements/flowmeters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters will be provided by Control Contractor.

3.13 STRAIGHTENING VANES

A. Provide straightening vanes where flow sensor manufacturer's installation instructions require greater length of straight upstream piping than can be obtained in available space.

3.14 WATER FILTERS

A. Install water filter in by-pass arrangement across system pumps. Allow clearance at top of filter for removal of cover and filter changes.

B. Install shut-off valves at filters and pressure gauges for measuring pressure drop across filters.

END OF SECTION 232120

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SECTION 232123 - PUMPS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) System

C. Section 23 0550 - Vibration Isolation

D. Section 23 2120 - Piping Specialties

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Pump curves with operating point clearly indicated. For parallel pump applications, indicate operating point of combined case as well as operating point of only one pump.
5. Motor data (refer to Section 20 0513 - Motors)
6. Seals
7. Materials of construction
8. Dimensions and weights
9. Manufacturer's installation instructions
10. All other appropriate data

B. Complete equipment data sheet attached at end of this Section for each piece of equipment and submit with Shop Drawings. Shop Drawings will be returned without review if data sheets are not provided for each piece of equipment and if data sheet is not filled out completely.

1.4 DESIGN CRITERIA

A. Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

B. Pumps shall meet or exceed operating efficiencies scheduled.

C. Furnish pumps complete with motors, impellers, drive assemblies, bearings and accessories as hereinafter specified. Furnish pump couplings with OSHA compliant coupling guards.

D. Where pump is indicated for parallel operation, scheduled conditions are for that pump with two pumps operating; i.e., total system flow rate is twice that scheduled for single pump. When only one of two pumps is operating, operating point of that pump must fall within manufacturer's recommended operating range.

E. Select motor with sufficient hp rating for non-overloading operation over entire pump curve.

F. Furnish each pump and motor with nameplate giving manufacturer's name, serial number of pump, capacity in gpm and head in ft at design condition, hp, voltage, frequency, speed and full load current.

G. Test pumps hydraulically at 150% of rated pressure per Hydraulic Institute Standards, clean and paint before shipment. Manufacturer shall certify all pump ratings.

H. Pumps shall operate without objectionable noise or vibration.

I. After completion of balancing, if water balancing results in pump discharge balancing valve being closed 50% or more, replace or trim impeller so that balancing valve is opened at least 75% to maintain design flow rate. Where pumps are driven by VFDs, balancing should be performed with pumps at design speed.

J. Furnish one spare seal for each pump to Owner.

K. Head for pumps submitted for pumping through evaporators and condensers of chillers and water coils shall be increased, if necessary, to match the equipment approved for project.

PART 2 - PRODUCTS

2.1 END SUCTION CENTRIFUGAL PUMPS (FLEXIBLE COUPLED)

A. Manufacturers: Bell and Gossett, Taco, Armstrong, Peerless, Aurora, Grundfos, PACO, Weinmann or Goulds

B. Pumps shall be base mounted, end suction, flexible coupled, cast iron casings with ANSI Class 125 flange, bronze fitted with working pressure of 175 psi and continuous operating temperature of 225°F. Pumps shall be back pull out design allowing for servicing of impeller and bearing assembly without disturbing piping, motor or requiring shaft realignment.

1. Pumps scheduled to have higher working pressure than175 psi shall have ductile iron casing with ANSI Class 250 flanges, rated for 300 psi working pressure and continuous temperature of 225°F.

C. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

D. Impellers shall be single suction enclosed type made of bronze, hydraulically and dynamically balanced to ANSI/HI 1.1-1.5-1994, Section 1.4.6.1.3.1, Figure 1.106 Balance Grade G6.3, keyed and locked to pump shafts and protected by replaceable bronze shaft sleeves.

E. Pump shafts shall be high strength carbon steel, sealed and gasketed from pumped fluid.

F. Pumps shall be furnished with mechanical seals with carbon rotating faces, ceramic stationary seats, Buna-N elastomer and 316 SS spring, rated up to 225°F continuous operation.

G. Bearing assemblies shall be cast iron with regreasable ball bearings

H. Spacer type couplings or couplings with extended hubs shall be used to allow for pump servicing. Couplings shall be Woods Dura-Flex or Sure-Flex in accordance with manufacturer's recommendation for their application.

I. Pumps shall be furnished with groutable steel base plates

J. Pump bases shall be furnished with drip pans and drain connections for pumps with packed stuffing box shaft seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in strict accordance with manufacturer's instructions to avoid any stress and misalignment.

B. Set base mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking grout. Use end caps during grouting to prevent overflow when end caps are not integral with base plates.

C. Fill under base plates of vertical turbine pumps with non-shrinking grout in accordance with manufacturer's recommendation and Hydraulic Institute Standards.

D. Align flexible coupled pumps after base grouting is complete. Align pump and motor in all four planes: vertical angular, horizontal angular, vertical parallel and horizontal parallel. Alignment shall be within the recommended value by manufacturer, but not over 1/64” for parallel alignment and 1/64” per inch of coupler radius for angular alignment. Record and submit all results of alignment procedure to Engineer.

E. Install full line size spring loaded check valve and balancing valve in pump discharge piping.

F. Where pump connection size and indicated line sizes are not identical, provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. Valves and piping specialties shall be full line size as indicated on drawings.

G. Provide 2” deep drain pan constructed of 16 ga 304 stainless steel, welded under fuel oil pump set and duplex fuel oil filter set.

3.2 STARTUP

A. Verify that piping system has been flushed, cleaned and filled.

B. Prime pump, vent air from casing and verify that rotation is correct. To avoid damage to mechanical seals, never start or run pump in dry condition.

C. Verify lubrication of motor and pump bearings and lubricate properly in accordance with manufacturer's recommendation and Section 20 0000, Part 3, under LUBRICATION.

D. After several days' operation, verify removal of disposable startup strainer in suction diffuser and turn them over to Owner.

E. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Section 23 0550 - Vibration Isolation.

END OF SECTION 232123

Pump Data Sheet

General

Project	_____
Identification	_____
Service	_____
Location	_____
Type	_____
Manufacturer	_____
Model Number	_____

Performance

Capacity (Flow)	_____
Head (Ft)	_____
Max. Net Positive Suction Head Req. (Ft)	_____
Efficiency (%)	_____
Horsepower required for non-overloading operation over entire pump curve	_____

Physical Characteristics

Suction Size	_____
Discharge Size	_____
Casing Material	_____
Impeller Material	_____
Shaft Sleeve Material	_____
Shaft Material	_____
Seal Type	_____
Seal Face Material	_____
Seal Seat Material	_____
Bearing Assembly Material	_____
Working Pressure & Continuous Operating Temp.	_____
Maximum Intermittent Temperature	_____

Motor

Manufacturer	_____
Horsepower	_____
Voltage	_____
Phase	_____
Hertz	_____
RPM	_____
Motor Type	_____
Enclosure Type	_____
Frame Type	_____
Insulation Class	_____
NEMA Design Designation	_____
Service Factor	_____
Nominal Efficiency	_____
Nominal Power Factor	_____
Full Load Amps	_____
Variable Frequency Drive Driven (Yes or No)	_____

Miscellaneous

SECTION 232514 - CHEMICAL TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 2116 - Pipe and Pipe Fittings

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings for each system including, but not limited to, the following:

1. Manufacturer's name and model number
2. Capacities/ratings
3. Chemicals; description of chemicals, its composition and function
4. Operating sequence
5. Composite wiring diagrams
6. Materials of construction
7. Dimensions and weights
8. Manufacturer's installation instructions
9. All other appropriate data

B. Submit overall installation diagram for each system locating chemical injecting points, bleed-off assemblies, water meters, number of tanks and pumps, and field piping.

C. Submit complete make-up water analysis.

D. Submit directly to Owner, Material Safety Data Sheets (MSDS) for all chemicals used in chemical treatment systems. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.

1.4 OPERATION AND MAINTENANCE DATA

A. Provide for services of manufacturer's trained, representative to approve installation, and instruct Owner's representative in operation, testing and maintenance of each system.

1.5 MAINTENANCE SERVICE

A. Provide service and maintenance of treatment systems for 1 yr from date of substantial completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.

C. Provide laboratory and technical assistance services for warranty period.

1.6 WATER ANALYSIS

A. Submit complete water analysis and results of performance test of each system signed by manufacturer's service representative.

B. Water analysis shall include the following:

1. Heating Hot Water:
   a. Hardness
   b. pH
   c. M" alkalinity
   d. Inhibitor level
   e. Total dissolved solids
   f. Temperature

1.7 DESIGN CRITERIA

A. Periodic test procedure and chemical shall be recommended for each system.

B. Chemicals shall be suitable for pipe material, fluid medium and intended treatment.

C. Materials of construction for equipment used shall be compatible with water treatment chemicals provided.

D. Treat the following systems:

1. Hot water

E. Provide initial chemical treatment and equipment for all systems based on complete system fluid analysis, including make-up water, prior to equipment installation.

F. Initial supply of chemicals for chemical treatment of each system shall be adequate for start up and testing period, for the time systems are being operated by Contractor for temporary heating and cooling, and for 1 yr after start-up of system.

G. Inhibitor for closed water systems shall use nitrites or phosphonate as primary inhibitor.

1.8 123ABWATER QUALITY REQUIREMENTS

A. Minimum water quality requirements for closed hot and/or chilled water systems shall be as follows:

1.	pH	8.0 – 9.0
2.	TDS	<500 ppm
3.	Hardness as CaCO3 and Alkalinity	30 – 120 ppm
4.	Chlorides	<200 ppm
5.	Sulphates	<200 ppm
6.	Iron	<1.0 ppm
7.	Ammonia	<2.0ppm
8.	Manganese	<0.4 ppm
9.	Nitrate	<100 ppm
10.	Dissolved Oxygen	<0.1 ppm
11.	Ryznar Index	>6.0
12.	Suspended Solids	≤10 micron
13.	Bacteria Counts	
a.	Total Aerobic Bacteria Counts	≤100 cfu per mL
b.	Total Anaerobic Bacteria Counts	≤10 cfu per mL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. GE Water & Process Technologies (formerly Betz-Dearborn)
2. Earthwise Environmental, Inc.
3. Ecolab (formerly Nalco)
4. HOH Chemical
5. Chem Aqua

2.2 PIPING SYSTEM CLEANER

A. Use cleaning compound to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system metals without deleterious effects. Cleaner shall not contain phosphate.

2.3 HOT WATER CHEMICAL TREATMENT

A. Provide by-pass type batch feeder to receive chemicals in liquid or pellet form. Each independent hot water heating system shall have separate feeder. Chemical treatment shall control corrosion and scale.

B. Feeder shall have capacity of 5 gal and shall be constructed of steel with minimum working pressure of 150 psig. Feeder shall be complete with air vent, drain valve, and inlet/outlet pipe connections.

C. Furnish feeders with screw type cover with replacement gaskets, or valved funnel opening and with exterior prime coat finish.

PART 3 - EXECUTION

3.1 APPLICATION OF CHEMICALS

A. Apply initial chemical treatment for each system after systems have been cleaned and flushed.

B. Add, adjust or modify treatment based on results of period tests until turned over to Owner.

3.2 PERFORMANCE TEST

A. Conduct performance test for each system to determine required capacity and performance of chemical treatment system. Refer to Part 1 for water analysis and water quality requirements.

B. Conduct water quality test in all systems weekly and submit test result reports to Mechanical Contractor and Owner until project is turned over to Owner.

C. Conduct water quality tests before and after new work tie-in to existing systems.

3.3 BATCH FEEDERS

A. Install in bypass arrangement at pump discharge as indicated.

B. Install ball valve in inlet line, balancing valve in outlet line and unions.

3.4 PIPE CLEANING

A. General:

1. Piping systems shall be cleaned before they are used for any purpose except pressure tests, which shall be conducted before cleaning. Add cleaner to closed systems at concentrations as recommended by cleaner manufacturer. Remove water filter elements from system before starting circulation.
2. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
3. Remove, clean, and replace strainer screens or filters.
4. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed.
5. New piping system shall not be connected to existing system for operation until flushing and cleaning have been completed. Obtain permission from Owner prior to opening up new work to existing system.

B. Water Systems:

1. Piping systems shall be filled, vented and circulated employing chemical cleaner solution for period of at least 24 hours or more in accordance with manufacturer's recommendations and job site chemical tests. Bring concentration to level, which raises M Alkalinity to manufacturer's recommended value above that for existing water used for fill. Conduct chemical tests to verify levels and submit results to Architect/Engineer. Flush detergent clear with continuous draining and make-up water fill for period of at least 12 hours or more until original M Alkalinity level is achieved (or until pH of system water is within 0.5 pH of make-up water). Conduct chemical tests to verify levels and submit results to Architect/Engineer. When cleaning process is complete, replace strainers or filters and reconnect permanent pumping apparatus.

END OF SECTION 232514

SECTION 233114 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Piping and Equipment Supporting Devices

B. Section 20 0700 - Mechanical Systems Insulation

C. Section 23 0550 - Vibration Isolation

D. Section 23 0595 - Air Systems Test Adjust Balance

E. Section 23 0902 - Control Valves and Dampers

F. Section 23 3314 - Ductwork Specialties

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards Metal and Flexible where applicable. Each duct system schedule shall include, but not be limited to, the following:

1. Name of Contractor/manufacturer fabricating each duct system
2. Material and gauge
3. Pressure class
4. Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system
5. Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures
6. Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge
7. Type of longitudinal seam
8. Fitting construction details
9. Support methods including spacing, upper attachments, and lower attachments
10. Sealant and gasket
11. Sealing class

B. Duct leakage testing methods, apparatus and apparatus certification signifying meter is in conformance with ASME Requirements for testing meters.

C. Duct liner including data on thermal conductivity, air friction correction factor, and temperature and velocity limitation.

D. Submit the following information for welded sheet metal ductwork:

1. Welding Procedure Specification (WPS) for welded joints. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "D".
2. Procedure Qualification Record (PQR) for each WPS. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "E".
3. Welder and Welding Operator Qualification Test Record (satisfactory performance) for each field or shop welder. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "F".

E. LEED Submittals:

1. Product Data for IEQ Prerequisite 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2007, Section 5 – “Systems and Equipment”.
2. Product Data for EA Prerequisite 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2007, Section 6.4.4 – “HVAC System Construction and Insulation”.
3. Leakage Test Report for EA Prerequisite 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2007, Section 6.4.4.2.2 – “Duct Leakage Tests”.
4. Duct Cleaning Test Report for IEQ Prerequisite 1: Documentation of work performed for compliance with ASHRAE 62.1-2007, Section 7.2.4 – “Ventilation System Start-Up”.
5. Product Data for IEQ Credit 4.1: For adhesives and sealants, including printed statement of VOC content.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

1.5 DESCRIPTION

A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.

B. Duct sizes indicated are net inside dimensions.

C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.6 DESIGN CRITERIA

A. All products shall conform to NFPA 90A, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than 2” WG for positive pressure ductwork and not less than -2” WG for negative pressure ductwork.

C. Ductwork shall comply with Local, State and Federal requirements.

D. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4” WG; pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than -2” WG.

E. Unless otherwise indicated, pressure class for fume hood exhaust ductwork between exhaust fan inlet and exhaust air terminal device outlet shall be equal to static pressure at exhaust fan inlet but not less than -4” WG.

F. Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less than ± 2” WG.

G. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.

H. Except as modified in this Section of specifications or on drawings, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:

1. HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10” WG and negative 10” WG and flat oval ductwork up to positive 10” WG.
   a. Tie rods shall be 1/2” or 3/4”, galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
   b. Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust, BSC exhaust, animal room exhaust, BSL-3 exhaust, cagewash exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.
   c. Internal tie rods or bracing are not allowed for ductwork 36” and smaller.
   d. Midpanel tie rods are not allowed.

2. Round Industrial Duct Construction Standards, 2nd Printing 1999
3. Round Industrial Duct Construction Standards, 2nd Edition, September, 1999
4. Rectangular Industrial Duct Construction Standards, 2nd Edition, 2004
5. Accepted Industry Practice for Industrial Duct Construction, 2nd Edition, 2008, for round ductwork -4” to 20” WG (Table 1-A) and for rectangular ductwork -4” to 20” WG (Table 2-A).
6. Adhesives and sealants used on installation of ducts shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168; Indoor Environmental Quality Section, Credit IEQ-4.1.

1.7 WELDING REQUIREMENTS

A. The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.

B. Procedure and Qualification:

1. Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by installing contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.
2. Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.
3. Establish and provide written quality assurance/quality control (QA/QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL SHEET

A. Lock Former Quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924/A924M or ASTM A653/A653M. Galvanized coating shall be G90.

B. Use G90 Galvaneal or Zincgrip where painting is specified.

2.2 ALUMINUM SHEET

A. Aluminum alloy, ASTM B209, Type 3003H-14 capable of double seaming without fracture.

2.3 STAINLESS STEEL SHEET

A. First quality, cold rolled annealed, pickled, ASTM A240 and A480, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.4 FLEXIBLE DUCT

A. Manufacturers: Thermaflex, or Flexmaster

B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.

C. Flexible duct shall have minimum ratings as follows:

1. Operating Temperature: -20ºF to 250ºF
2. Internal Working Pressure: Positive: 6" WG
   Negative: 1" WG
3. Burst Pressure: 2-1/2 times working pressure
4. Velocity: 5000 fpm

D. Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film, CPE film, or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix without adhesive.

E. Insulation shall be flexible fiberglass insulation with minimum R-value of 6 at mean temperature of 75ºF. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with maximum perm rating of 0.05 permper ASTM.

F. Insulation material shall not be exposed to air stream.

G. Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 ft or 10 ft straight duct shall not be less than the following:

Dynamic Insertion Loss (dB)
Octave Band Center Frequency (Hz)
(Based on 5 ft length)

Duct Diameter (in)	125	250	500	1000	2000	4000
6"	6	9	18	22	24	15
8"	6	10	18	20	21	12
10"	5	11	18	18	18	9

(Based on 10 ft length)

Duct Diameter (in)	125	250	500	1000	2000	4000
6"	10	15	28	33	35	22
8"	10	18	29	32	32	20
10"	9	19	28	31	29	18

2.5 SNORKEL (LOCAL EXHAUST VENT) DUCT CONSTRUCTION

A. Equal to Dura-Vent Model 2PA, two-ply polyester-acrylic urethane blend coating, white color, -40ºF to 250ºF.

B. Use stainless steel ductwork for snorkel to the point connected to main exhaust ductwork.

2.6 MANUFACTURED ROUND OR FLAT OVAL DUCTWORK (POSITIVE PRESSURE)

A. Single Wall:

1. Manufacturers: Lindab, Semco or McGill AirFlow, equal to McGill AirFlow Uni-Seal duct and fittings suitable to positive 10” WG.
2. Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80” diameter with minimum 16 ga. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
3. Unless otherwise indicated, connection shall be slip type with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
4. Internal bracing is not allowed.
5. Pre-sealed snaplock pipe system “Greenseam +” as manufactured by Ductmate Industries may be used for low pressure supply air duct.

B. Double Wall (insulated):

1. Manufacturers: Lindab, Semco or McGill AirFlow duct and fittings suitable to positive 10” WG.
2. Ducts shall be machine formed round and flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Inner liner shall be perforated or solid as indicated, and annular space shall be filled with 1” thick fiberglass insulation. Use fittings with solid liner as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
3. Unless otherwise indicated, connection shall be slip type connection with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
4. Internal bracing is not allowed.

2.7 MANUFACTURED ROUND DUCTWORK (NEGATIVE PRESSURE)

A. Manufacturers: McGill AirFlow Industrial duct and fittings. Semco and Lindab are acceptable manufacturers, provided meeting requirements in this Section.

B. Ducts shall be machine formed round duct constructed of G90 galvanized steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

C. Connection shall use slip coupling, angle ring or Van Stone connectors in accordance with manufacturer's recommendations.

D. Round spiral duct gauge/reinforcement shall be as follows:

Duct Diameter (”)	-10” to -20” WG Gauge/Reinforcement
3 - 7	26 ga
7-1/2 - 8	26 ga
8-1/2 - 12	24 ga
12-1/2 - 15	22 ga
16 - 18	20 ga

Duct Diameter (")	-10" to -20" WG Gauge/Reinforcement
19 - 22	18 ga
23 - 26	18 ga
27 - 34	18 ga w/AR 12 ft c/c or 16 ga
35 to 42	18 ga w/FL + AR 6 ft c/c or 16 ga w/FL
44 - 50	18 ga w/FL + AR 4 ft c/c or 16 ga w/FL
52 - 60	18 ga w/FL + AR 4 ft c/c or 16 ga w/FL
62 - 70	16 ga w/FL + AR 6 ft c/c or 14 ga w/FL

AR = single angle ring reinforcement at maximum indicated ft on center spacing.

FL = fully welded flange angle rings as joint connections at maximum 12 ft spacing.

E. Fitting gauge shall be one even gauge heavier than the lightest allowable gauge of connecting downstream section of duct.

2.8 DUCT SEALANTS AND GASKETS

A. Sealant:

1. Flexible, water based, adhesive sealant compounded specifically for sealing joints and seams in ductwork. Hardcast, McGill AirSeal, Ductmate PROseal, Mon-Eco Industries, Childers, DP1010 or H.B. Fuller/Foster.
2. Sealants shall be UL 723 (ASTM E84) classified, and meet NFPA 90A and 90B.
3. Sealants shall comply with requirements for LEED IEQ 4.1.
4. Select sealants as recommended by manufacturer for specific application.
5. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, VOC compliance with LEED IEQ 4.1, detailed installation instructions.
6. Duct tapes are not allowed.

B. Gaskets:

1. Butyl, copolymer or neoprene based tape similar to Ductmate 440 Gasket Tape or Neoprene Gasket Tape for flanged joints.

C. Duct Sealant and Gaskets for Fume Hood Exhaust Ductwork:

1. Sealant shall be similar to Hardcast Sure-Grip 404 or Ductmate Proseal.
2. Gasket material shall be Butyl tape similar to Ductmate 440 Gasket tape or neoprene gaskets.
3. Gasket thickness and width shall be as required for flange and surface irregularities to seal joint air tight.

2.9 CABLE SUSPENSION SYSTEM

A. Suspension system shall be similar to Gripple Hang-Fast as manufactured and supplied by Gripple Incorporated or Ductmate Industries “Clutcher” cable hanging system.

B. Suspension system shall be load rated and verified by SMACNA Testing and Research Institute to be in compliance with SMACNA HVAC Duct Construction Standards, 2005, Chapter 5.

2.10 ACOUSTIC DUCT ENCLOSURE

A. Enclosure shall consist of inner layer (2” thick, minimum 3 psf glass or mineral fiber similar to Type R insulation specified in Section 20 0700 - Mechanical Systems Insulation) and outer layer of 2 layers of 5/8” sheet rock with staggered seams, attached to sheet metal studs. Sheet rock shall be attached to structure not ductwork.

2.11 ACOUSTIC DUCT COVERING

A. Sound barrier material shall be similar to Kinetics Model KNM-100B or EAR Lag-10. Barrier material to have acoustic ratings of STC-27, 1.0 lb/ft^2 weight, and minimum continuous operating range from -10°F to 180°F.

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB)					
Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
15	18	21	27	32	37

PART 3 - EXECUTION

3.1 GENERAL

A. Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.

B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.

C. Ductwork shall be free of kinks and dents.

D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this section of specifications or on drawings.

E. Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 25° per side (50° total converging).

F. Provide transitions at ductwork system components and connections to equipment. Refer to Specification Section 23 3713 – Diffusers, Registers, and Grilles, for additional information regarding diffuser/register/grille connections.

G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.

H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.

I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

J. Support coils, filters, air terminals, dampers, sound attenuator devices or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.

K. Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.

L. Install outside air intake duct to pitch down at minimum 1” per 20 ft toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.

M. Install exhaust air duct to pitch down at minimum 1” per 20 ft toward exhaust louver.

N. Blank off unused portion of outside air intake or exhaust louvers.

O. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.

P. Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified in Section 23 0901 - Control Systems Integration.

Q. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.

R. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:

1. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.
2. Apply cold galvanizing material equal to ZRC Products, Inc.

3.2 ELBOWS

A. Rectangular Duct (SA/RA/EA):

1. Use radius elbows with centerline radius to width ratio of 1.5 (SMACNA Type RE 1).
2. Where 1.5 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 1.0 (SMACNA Type RE 3).
3. Where 1.0 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 0.75 (SMACNA Type RE 3) or 45° throat with radius heel elbows (SMACNA Type RE 8).
4. Use splitter vanes for 1.0 radius elbows, 0.75 radius elbows and 45° throat with radius heel elbows as follows;
   a. No vanes for duct with width less than 24”
   b. Single vane for duct with width 24” to 36”
   c. Two vanes for duct with width over 36”
5. Fabricate splitter vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).
6. Square throat elbows with or without turning vanes are not allowed unless specifically indicated. Square throat elbows without turning vanes may be used for transfer air ducts.

B. Round and Oval Duct:

1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5 regardless of duct velocity. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.3 LONGITUDINAL SEAM

A. Rectangular Duct:

1. Unless otherwise indicated, use Pittsburgh lock seam.
2. Seal longitudinal seams with approved sealant or pre-sealed with encapsulated mastic.
3. Button punch snap lock construction (SMACNA L-2) may be used for ductwork that is both 2” WG (+ or -) and lower, and 36” and smaller in width or height. For ductwork over 24” in width or height, add screw 4” from each end.
4. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling.
5. Button punch snap lock construction is not allowed on aluminum ductwork.

B. Round and Oval Duct:

1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards with the following exceptions.
   a. SMACNA seam types RL-3, 6A, 6B, 7 and 8 shown in Figure 3-2 are not allowed.

3.4 TRANSVERSE JOINT

A. Rectangular Duct:

1. Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.
2. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.
3. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2” x 1-1/2” x 1/4" angle at each side of transverse joint.
4. Refer to Detail for non-externally insulated outdoor ductwork.

B. Round and Flat Oval Duct:

1. Unless otherwise indicated, use beaded sleeve joints (SMACNA RT-1) with minimum 2” insertion length or flange joints (SMACNA RT-2 or RT-2A).
2. Connection systems manufactured by Ductmate Industries (Spiralmate and Ovalmate) or McGill AirFlow (Uni-flange) may be used for supply air ductwork.
3. AccuFlange connected systems may be used with gaskets specified in Part 2 of this Section.
4. Lindab SPIROsafe or McGill AirFlow (Uni-Gasket) self-sealing duct system will be acceptable for **[supply] [supply and return]** air ductwork.

3.5 DUCT SUPPORTS

A. Unless otherwise indicated, use straps or Z bar hangers with 3/8” rods to support rectangular ducts 60” wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60” wide.

1. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Section 20 0700 – Mechanical Systems Insulation and details.

B. For round ducts 24” diameter or smaller, use single hanger.

1. Cable Suspension System may be used up to 24” diameter at spaces higher than 8 ft above floor or platform.
2. Round Duct Strap Bracket by Ductmate Industries may be used up to 24” diameter.

C. For round ducts 25” diameter or larger, use 2 minimum 3/8” rods, with trapeze in accordance with the following schedule:

Duct Size	Trapeze (Half Round)
25” to 36”	1-1/2” x 1-1/2” x 1/8"
37” to 48”	1-1/2” x 1-1/2” x 1/4" or 2” x 2” x 1/8"
49” to 60”	2” x 2” x 1/4"
61” to 84”	2-1/2” x 2-1/2” x 1/4"

D. Refer to Section 20 0700 - Mechanical Systems Insulation for ductwork insulation, weight bearing inserts and insulation protection shield requirements.

E. Support ducts located on roof as detailed.

F. Support vertical ducts at every floor, but not exceeding 12 ft.

G. Support flexible duct at manufacturer’s recommended intervals but at least every 5 ft. Maximum sag shall be 0.5” per ft between supports. Hanger or saddle material in contact with flexible duct shall be minimum 0.5” wide.

H. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:

1. Hook or loop
2. Nailed pin fasteners
3. Expansion nails without washers
4. Powder actuated fasteners (forced entry anchors). Forced entry anchors may be used for upper attachments of flexible ductwork supports.
5. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)
6. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 5-4 of SMACNA HVAC Duct Construction Standards 2005)
7. Wire hanger
8. Trapeze hangers supported by wires or straps
9. Rods, straps or welded studs directly attached to metal deck
10. Drilled hole with attachment to structural steel
11. Lag screw expansion anchor
12. Rivets
13. Non-metallic hangers or straps

I. Supporting devices shall be standard products of manufacturers having published load ratings.

J. Refer to Section 20 0529 - Piping and Equipment Supporting Devices for additional support requirements including attachments to structures.

K. For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.

L. Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required

for concrete decking. For concrete decking, consult with the project structural engineer for location and size of opening prior to execution of Work.

3.6 SHEET METAL WELDING

A. Welded ductwork shall be butt-welded unless otherwise indicated. Backing material and slip joints are not allowed.

1. SMACNA T-21 or T-21a welded flange joints are acceptable with continuous welding including at each corner for rectangular ducts.

B. Attach welding cable leads directly to base metal to be welded. Do not jumper welding cable leads through building structure, to avoid emission of stray voltage/current through building structure.

C. Welds on exposed ductwork in occupied spaces shall be brush polished with stainless steel brush.

D. Welds at exterior of building shall be ground smooth and brush polished with stainless steel brush to prevent atmospheric contamination and rust formation.

3.7 PROTECTION OF DUCTWORK

A. Protect ductwork during construction against entry of foreign matter and construction dirt.

B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.

C. If ductwork is not protected, remove dirt and foreign matter from the duct system and obtain inspection and approval from Engineer upon completion of cleaning before operating fans.

D. Return fans are not allowed to operate during construction to avoid intake of construction dirt/dust into return air ductwork.

3.8 DUCT LEAKAGE TEST

A. Refer to Test and Balancing portion of Section 20 0000 - General Mechanical Requirements.

B. Owner and/or Owner's representative may elect to witness leakage tests. Notify Owner and/or Owner's representative at least 3 days in advance.

C. Test each supply, return, and exhaust ductwork as follows, unless otherwise indicated in this section or in schedules.

1. Test 100% of total installed duct area for duct pressure positive or negative Class 3” wg and higher.
2. Test 25% of total installed duct area for duct pressure positive or negative Class 2” wg.
3. Test 100% of total installed duct area for ductwork located in inaccessible spaces including shafts.

4. Engineer will select sections of ductwork to be tested.
5. If test results are acceptable to Engineer, remainder of ductwork is permitted to proceed without further testing. If ductwork fails test, repair all ductwork including ductwork not tested. Then repeat leakage tests for new sections of ductwork as described above.

D. Leakage test procedures shall be in accordance with test method described in Section 3 of SMACNA HVAC Air Duct Leakage Test Manual, except as modified in this Section. Test apparatus shall be in accordance with Section 5 of SMACNA HVAC Air Duct Leakage Test Manual.

E. Test pressure shall be equal to duct pressure class. Negative pressure ductwork shall be tested with negative test pressure.

F. Air leakage shall not exceed limits specified or scheduled. If leakage exceeds allowable limits, identify leaked areas, repair, seal and retest.

G. Provide filter system on duct inlet to test blower. Filter system shall be equal to final filtering efficiency of AHU supply air duct system. Filters are not required for negative pressure testing.

H. Do not insulate ductwork until it has been successfully tested.

I. Maximum permitted leakage of ductwork systems are indicated on schedules on drawings.

J. Maximum permitted leakage (L) in cfm/100 sf duct surface area of each ductwork shall be calculated by:

$L = C_L \times P^{0.65}$

1. P = test pressure (duct pressure class).
2. C_L = duct leakage class, 2 for round/oval ducts and 4 for rectangular ducts and flexible ducts.
3. Total allowable leakage in a duct section:
   = L x (total duct surface area of the section)

K. Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below.

1. When using test apparatus and procedure described in <u>SMACNA HVAC Air Duct Leakage Test Manual</u>, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:
   a. 1 cfm per 1" WG of static pressure is allowed for the test equipment and test connections (e.g. 3 cfm when testing at 3" WG).
   b. 0.10 cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm for a cap on 10" diameter duct).

2. To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Client's Representative and repaired by welding. No caulking or sealing is allowed.

3.9 LOW PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 2” WG AND UNDER)

A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2” into duct. Sheet metal "TEK" screws 3/4” in length may be used as fasteners in conjunction with factory made transverse joints.

B. Unless otherwise indicated, construct branch take-off fittings as follows:

1. For branch take-offs including branch ducts serving more than one diffuser or grille, use 45° entry fittings. For supply air ducts, conical taps may be used.
2. For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.

C. Splitter dampers and/or extractors are not allowed.

3.10 HIGH PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 3” WG AND OVER)

A. Use manufactured ductwork or contractor fabricated ductwork meeting specified Construction Standards and fitting performance.

B. Submit construction details including materials, type of service, reinforcing methods, and sealing procedures.

C. Use elbows, tees, laterals, crosses and accessory fittings as shown on drawings and as required to fabricate duct system.

D. Use conical tees for round ductwork and 45 degree entry fittings for branch take-offs from mains unless otherwise indicated.

E. Provide manufactured bellmouth fittings at each fan supply air plenum to provide smooth entrance of air into duct system.

F. Provide positive pressure relief doors as indicated on drawings.

G. Provide negative pressure relief doors as indicated on drawings.

H. Ductwork pressure class is indicated on drawings.

3.11 FLEXIBLE DUCT

A. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.

B. In supply air systems without air terminal devices, flexible ducts may be used for final connections to diffusers, grilles, and registers. Flexible ducts shall be of minimum length required to make connections, but shall not be greater than 6 ft in length, unless noted otherwise.

C. In supply air systems with air terminal devices, flexible ducts shall be used for duct connections to diffusers, grilles, and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall be 6 ft long.

D. In return and general exhaust air systems without air terminal devices, flexible ducts may be used for final connections to return grilles and registers and general exhaust grille and registers. Flexible ducts shall be of minimum length required to make connections, but no greater than 6 ft in length, unless noted otherwise.

E. In return and general exhaust air systems with air terminal devices, flexible ducts shall be used for duct connections to grilles and registers for sound attenuation purposed, except above non-accessible ceilings. Flexible ducts shall be minimum 6 ft long and maximum 8 ft long.

F. Centerline radius of bends shall not be less than one duct diameters. FlexFlow Elbow supports by Thermaflex or similar products shall be used at diffuser/grille connection to assure full radius elbow.

G. Support flexible ductwork with min 1-1/2” wide saddle at a maximum of 5 ft on center and at elbow, with no portion lying on ceiling supporting system.

H. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.

I. Connect flexible duct liner to collars and rigid duct with stainless steel draw bands. If collars have beads, position draw bands behind beads.

J. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.

K. Flexible ducts are not allowed above non-accessible ceilings.

L. Flexible ducts are not allowed in high pressure ductwork.

M. Flexible ducts are not allowed for special exhaust systems, such as fume hood exhaust, BSC exhaust, animal room exhaust, BSL-3 exhaust, cagewash exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.

N. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.12 ACOUSTIC DUCT COVERING

A. Wrap outside of duct with inner layer material. Apply outer layer material over inner layer material. Do not rigidly tie outer layer material to ductwork.

B. If manufactured barrier materials are used, install in accordance with manufacturer's installation instruction.

C. Apply covering to the following ductwork:

1. Ductwork as indicated to be covered
2. Supply and return ductwork for 20 ft from roof top air handling units

3.13 FUME EXHAUST DUCT CONSTRUCTION

A. General:

1. Construct elbows with centerline radius to width or diameter ratio of at least 1.5 and 45° lateral branch take-offs from mains.

B. Stainless Steel Ducts:

1. Use 18 ga or heavier 304 stainless steel sheet with all joints and seams butt-welded airtight.
2. Use longitudinal seam construction with seam at top on horizontal runs. Spiral seams are not allowed on round duct.

C. Galvanized Steel Ducts:

1. Use galvanized steel sheet, spiral seam construction.
2. Refer to Manufactured Round Ductwork (Negative pressure) in Part 2 of this Section.

3.14 STERILIZER EXHAUST DUCT CONSTRUCTION

A. Use aluminum duct for exhaust from sterilizer piping spaces when enclosed in separate room and for exhaust located above sterilizer doors. Fabricate all duct work downstream of first location where this occurs to exhaust fan inlet of aluminum construction. Seal or weld aluminum duct air and water tight. Fan discharge duct and other exhaust duct located upstream of point where aluminum duct is required may be of aluminum or galvanized steel construction sealed in accordance with its pressure class.

END OF SECTION 233114

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SECTION 233314 - DUCTWORK SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0595 - Air Systems Test Adjust Balance

B. Section 23 0902 - Control Valves and Dampers (Control and Smoke Dampers)

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Capacities
3. Temperature/pressure ratings
4. Materials of construction
5. Dimensions
6. Manufacturer's installation instructions and/or detailed drawings
7. All other appropriate data

B. LEED Submittals:

1. Product Data for IEQ Prerequisite 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2007, Section 5 – “Systems and Equipment”.

1.4 DESIGN CRITERIA

A. Products and materials shall conform to NFPA Section 90A, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct or unit at where the specialties are mounted, unless otherwise noted.

C. Unless otherwise noted, ductwork specialties shall be designed and constructed for pressure class of ductwork in which they are installed.

PART 2 - PRODUCTS

2.1 MANUAL BALANCING DAMPERS

A. Manufacturers: Ruskin, Greenheck, Vent Products, Pottorff or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.

B. Rectangular Dampers:

1. For low pressure ductwork, for damper blade height up to 12”, use single blade type with minimum 22 ga galvanized steel blade with minimum 3/8” rod for blade width up to 18”, and with minimum 18 ga galvanized steel blade with minimum 1/2” continuous rod for blade width from 19” to 48”. For damper blade height more than 12”, use multiple blade type with minimum 16 ga galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga and 6” to 8” maximum blade width, minimum 1/2” continuous rod and 1/2” x 1/2" galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48” in width or height in multiple sections with mullions.
2. For high pressure ductwork, dampers shall be constructed to withstand maximum pressure of 5” WG at closed position and maximum velocity of 2000 fpm at open position. Frame and blades shall be constructed of minimum 16 ga with minimum 1/2” diameter or square rod.

C. Single Blade Round Dampers:

1. For low pressure ductwork, damper shall have blade 24 ga, but no less than two gauges more than duct gauge. Rod shall be minimum 3/8” diameter or square continuous. Bearings shall be nylon or molded synthetic.
2. For high pressure ductwork, damper blade shall be minimum 16 ga. Rod shall be minimum 1/2” square continuous and tack welded to blade. Provide sealed end bearing similar to Ventlok #609 and acorn nut type dial regulator similar to Ventlok #635 or 641.

D. Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.

E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.

F. Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

2.2 SPLITTER VANES AND TURNING VANES

A. Radius Elbow Splitter Vanes (SMACNA Type RE-3):

1. Splitter vanes for radius elbows shall be constructed in accordance with SMACNA HVAC Duct Construction Standards Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).

B. Turning Vanes (SMACNA Type RE-2):

1. Turning vanes are not allowed unless specifically indicated.

2.3 BACKDRAFT DAMPERS

A. Manufacturers: Air Balance, Inc., American Warming and Ventilating, Pottorff, Louvers and Dampers, Inc., Advanced Air, Vent Products, Greenheck or Ruskin

B. Dampers shall be multi-blade, weighted type with counter-balanced blades and with galvanized steel or aluminum frame equal to Ruskin Type CBD-4. Blade edges to have vinyl gasket or polyurethane foam seals with ball bearings. Dampers to be suitable for flange and gasket connection to ductwork.

2.4 FIRE DAMPERS

A. Manufacturers: Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff Louvers and Dampers, or Ruskin

B. Fire damper assemblies shall be listed by UL 555 with 165°F fusible link and shall meet construction standards as set forth in NFPA 90A.

C. Fire resistance rating of fire dampers shall be as shown on drawings.

D. Dampers shall be dynamic type dampers rated to minimum 2000 fpm and 4” WG.

E. Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers.

F. For round ducts, dampers similar to Ruskin Model FDR25 may be used where products are suitable for duct size, velocity and static pressure.

G. Damper fire rating shall be compatible with rating of building surface in which damper is used.

H. Submit UL installation details showing mounting method and duct connection method.

I. Where ceiling fire dampers are used, they shall be similar to Ruskin CFD(R) 2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Ruskin, Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff, Louvers and Dampers similar to Ruskin FSD-60

B. Dampers shall meet requirements of NFPA 90A. Dampers shall be 1-1/2 or 3 h rated as shown on drawings, leakage rated at no higher than leakage Class I (4 cfm/ft^2 at 1" WG and 8 cfm/ft^2 at 4" WG) under UL 555/555S at temperature category 350°F, and compatible with system static pressures. Furnish dampers with factory-mounted, caulked sleeves and damper operators.

C. Dampers shall use airfoil shaped damper blades. Dampers shall be rated for minimum 4” WG static pressure and 2000 fpm air velocity.

D. For round ducts, dampers equal to Ruskin Model FSDR 25 may be used.

E. Operators shall be 120 V electric powered with auxiliary switch built in for position indication, factory installed outside airstream, linked to dampers for fail closed operation, and be UL Listed

and labeled for the application. Operators to be capable of closing damper at pressures encountered in system.

F. Dampers shall be furnished with heat sensor set at 165°F.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Smoke detector required at each damper will be provided by Electrical Contractor.

I. Submit UL installation details showing mounting method and duct connection method.

2.6 SMOKE DAMPERS

A. Manufacturers: Air Balance, Johnson Controls, Ruskin, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff, Louvers and Dampers or Prefco, similar to Ruskin SD-60.

B. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft^2 at 1" WG and 8 cfm/ft^2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 4” WG in closed position and to 2000 fpm in open position.

C. For round ducts, dampers equal to Ruskin Model SDRS 25 may be used.

D. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.

E. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

F. Actuators shall be 120 V electric powered with auxiliary switch built in for position indication.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Damper actuators shall be pneumatic with 20 psig air. Provide 120 VAC E-P switches to interface with Fire Protection System.

I. Smoke detector required at each damper will be provided by Electrical Contractor.

2.7 ACCESS DOORS

A. Access doors shall be rectangular, minimum 22 ga frame and minimum 24 ga door, fit air tight with neoprene gasket and shall be suitable for duct pressure class. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners are not acceptable.

B. Low Pressure Ducts (Pressure Class 2” and Under):

1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.

2. Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.
3. Sandwich style access doors made by Ductmate, Ward Industries, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

C. High Pressure Ducts (Pressure Class 3” and Over):

1. Use access doors factory fabricated and rated by manufacturer's published literature for installation in systems with pressures to positive or negative 10” WG.
2. Sandwich access doors made by Ductmate, Ward Industries, Pottorf, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

2.8 DUCT FLEXIBLE CONNECTIONS

A. Manufacturers: Unless specifically indicated, Ventfabrics, Inc. or Duro Dyne, equal to Duro Dyne model indicated. Material shall be glass fabric, fire retardant, waterproof, air tight and comply with NFPA 90A and 701 (formally UL 214).

B. General Supply, Return and Exhaust Ductwork:

1. Material for indoor use to be 30 oz per square yard, double coated with neoprene, tensile strength of 500 lbs x 500 lbs, tear strength of 13 lbs x 13 lbs, suitable for -40°F to 200°F continuous operation similar to Duro Dyne Neoprene.
2. Material for outdoor use shall be combination of inner layer of Duro Dyne Neoprene and outer layer of 24 oz per square yard, coated with Hypalon, UV resistant, suitable for -40°F to 250°F, similar to Duro Dyne Durolon.

C. Special Exhaust Ductwork:

1. Material for indoor use shall be 17 oz per square yard, teflon or silicon coated, tensile strength of 200 lbs x 250 lbs, tear strength of 50 lbs x 40 lbs, suitable for -65°F to 500°F, similar to Duro Dyne Thermafab.
2. Material for outdoor use shall be combination of inner layer of Duro Dyne Thermafab and outer layer of Durolon.

2.9 SOUND ATTENUATING DEVICES

A. Manufacturers: Semco, United McGill, Aeroacoustic, Vibro-Acoustics, VAW Systems, Price, or Ruskin

B. Units shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 Standard. Each test shall have been conducted within last 12-month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.

C. Outer casing of units shall be not less than 22 ga G90 galvanized steel in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork for 8” WG or pressure class indicated for duct system, if it is higher than 8” WG. Seams shall be lock formed or continuously welded and mastic filled.

D. Acoustic Materials:

1. Media shall be long fiber fiberglass protected with covering material and lined with not less than 26 ga galvanized perforated steel. Filler and facing material shall meet requirements of NFPA 90A with flame spread rating of 25 or less, and smoke development rating of 50 or less.
2. Media shall be non-fiberglass containing 100% natural cotton fibers treated with EPA registered, non-toxic borate solution, "flash dried" to actively inhibit growth of mold, mildew, bacteria and fungi. Media shall not contain any formaldehydes, phenolic resins or Volatile Organic Compounds (VOC's) that can off-gas, and/or cause health concerns. Media shall be 100% recyclable. Media shall comply with UL181 and NFPA 90A. Media shall not cause or accelerate corrosion of aluminum or steel.

E. Covering Materials:

1. Covering material shall be glass fiber cloth, high tensile strength, long strand glass fiber woven to thread count of 44 x 32 and have minimum weight of 6 oz per square yard, minimum breaking strength 250 x 200 lbs/in, similar to Burlington Style 1675, BGF Industries Style 1528, or JP Stevens Style 7628.
2. Covering material shall be Mylar film.
3. Provide spacers between covering material and perforated metal.

F. Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.

G. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

H. Sound Attenuating Devices for Exhaust Air Terminal Units Serving Fume Hood and Snorkel Exhaust:

1. Tubular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8” WG, inside to outside of casing.
2. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

I. Sound Attenuating Devices for General Exhaust Air Terminal Units of Laboratory Exhaust Systems:

1. Tubular type constructed entirely of galvanized steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8” WG, inside to outside of casing.
2. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

J. Sound Attenuating Devices for Fume Hood Exhaust Fans:

1. Provide units at exhaust fan intakes and discharges as scheduled. Unit length shall be as scheduled.
2. Rectangular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8” WG inside to outside of casing.

2.10 BIRD AND INSECT SCREENS

A. Bird screens shall be 1/2” square mesh formed with 0.063” diameter aluminum wire. Insect screen to be 18 x 16 with 0.017” diameter aluminum mesh.

B. Frame shall be removable type of minimum 12 ga, extruded aluminum.

2.11 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Young Regulator Co. or Metropolitan Air Technology similar to Young Regulator Model 830 dampers, furnished with Bowden 270 Series remote cable controls.

2.12 INSTRUMENT TEST HOLES

A. Manufacturers: Ventlok 699 (up to 1” insulation thickness) or Ventlok 699-2 (over 1” insulation thickness).

B. Use concave gaskets for round ductwork.

PART 3 - EXECUTION

3.1 MANUAL BALANCING DAMPERS

A. Install manual balancing dampers in supply, return and exhaust branch ducts, as shown on drawings and as required to regulate airflow to meet air balance requirements.

B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.

C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

D. Do not install balancing dampers in supply ductwork upstream of air terminal devices.

E. Balancing dampers are not required for **[return] [return and exhaust]** ductwork at outlet side of air terminal devices.

F. Balancing damper is not required where terminal air device serves a single diffuser or grille.

G. Do not install manual balancing dampers in the following exhaust ductwork:

1. Fume hood exhaust ductwork.
2. Kitchen hood exhaust ductwork.

3.2 SPLITTER VANES AND TURNING VANES

A. Install splitter vanes (SMACNA Type RE-3) as shown on drawings and as specified in Section 23 3114 – Ductwork, for rectangular radius elbows. Install splitter vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.

B. Turning vanes (SMACNA Type RE-2) are not allowed unless specifically indicated.

3.3 BACKDRAFT DAMPERS

A. Install backdraft dampers where indicated on drawings.

B. Where motorized dampers are shown in exhaust fan discharge duct, or in duct connecting to relief or exhaust louver, backdraft dampers are not required unless specifically indicated. Where motorized dampers are not shown, provide backdraft dampers in these locations.

3.4 FIRE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers where shown on drawings in accordance with manufacturer's installation instructions and requirements of NFPA 90A. Install dampers complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors. Install duct access door at each damper with door size large enough to permit replacement of fusible links and resetting of dampers.

B. Test and demonstrate proper operation of each damper after system is installed and ready for operation.

1. Manually test each damper for proper operation by removing fusible link or actuating EFL or PFL. Repair or replace any damper that does not close completely. Replace fusible link and certify in writing that each damper was installed according to manufacturer's installation instructions and that each damper can be expected to close completely when fusible link melts.
2. Notify Owner and/or Owner’s representative at least 48 h prior to testing to allow for witnessing.

C. Contractor shall provide letter from manufacturer's representative indicating that dampers are installed per manufacturer's installation instructions.

3.5 ACCESS DOORS

A. Install access doors where specified, indicated on drawings, and in locations where maintenance, service, cleaning or inspection is required, including automatic dampers, fire dampers, smoke dampers, smoke detectors, fan bearings, heating and cooling coils, reheat coils, humidifiers, filters, bird/insect screens, valves and control devices within duct or casing, at outside air intake duct and at inlet side of turning vanes in return ductwork.

B. Locate access doors for greatest ease of access.

C. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

Rectangular Duct Size	Minimum Access Door Quantity and Size
10”and smaller	(1) 8” x 8”
12” to 15” and smaller	(1) 10” x 10”
16” to 21”	(1) 14” x 14”
22” to 27”	(1) 18” x 18”
28” to 47”	(1) 24” x 24”
48” to 96”	(2) 24” x 24”

Round Duct Size	Minimum Access Door Size
10” and smaller	8” x 4”
15” and smaller	12” x 8”
29” and smaller	16” x 12”
30” and over	24” x 18”

D. Increase duct size to accommodate access door size indicated above where required.

3.6 DUCT FLEXIBLE CONNECTIONS

A. Connect ductwork to fans or casings containing rotating equipment or mounted on vibration isolators with duct flexible connections. Installed width shall be suitable for specific application but shall not be less than 4”. Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection.

B. Duct flexible connections are not allowed for fan connection serving kitchen hood, or perchloric acid hood.

3.7 SOUND ATTENUATING DEVICES

A. Install sound attenuating devices as indicated on drawings and/or as scheduled.

B. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners in accordance with manufacturer's recommendations for multiple unit installation.

3.8 BIRD AND INSECT SCREENS

A. Provide bird screens or insect screens as indicated on drawings at louvers and at intake/exhaust openings.

B. Unless otherwise indicated, provide bird screens where filters are specified and insect screens where filters are not specified.

3.9 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Install remote operated volume control dampers and remote operators as indicated on drawings.

B. Install connecting wire in the wall.

3.10 SMOKE DAMPERS AND DETECTORS

A. Install smoke dampers in locations indicated on drawings. Allow room for operator installation and access to operator. Install access door in ductwork for access to damper. When damper is installed in location other than in smoke or fire rated wall, use SMACNA seal class A for ductwork between smoke damper and smoke rated wall for affected zone.

B. Smoke detectors will be provided by Electrical Contractor in locations indicated on drawings. Install access door in ductwork for access to detector sampling device.

3.11 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.

B. Provide ductwork instrument test holes as shown on drawings, or as directed by TAB personnel, or Engineer.

END OF SECTION 233314

SECTION 233400 - FANS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) System

C. Section 23 0550 - Vibration Isolation

D. Section 26 2816 - Enclosed Switches and Circuit Breakers

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Fan curves
5. Materials of construction
6. Sound power levels
7. Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
8. Wheel type, diameter, rpm, tip speed
9. Required fan hp including drive losses
10. Motor data (refer to Section 20 0513 - Motors)
11. Vibration isolators furnished with fans
12. Dimensions and weights
13. Special coatings where applicable
14. Color selection charts where applicable
15. Manufacturer's installation instructions
16. All other appropriate data

B. Fan curves shall include series of curves indicating relationship of flow rate (cfm) to static or total pressure for various fan speeds, brake hp curves, and selection range (surge curves, maximum rpm, etc.).

C. Indicate performance data, based on both design air quantity and 110% of design air quantity.

D. For variable air volume application, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves including data to indicate effect of variable frequency drives on flow, pressure and hp.

E. Complete equipment data sheet attached at end of this Section for each piece of equipment and submit with shop drawings. Shop Drawings will be returned without review if data sheets are not provided for each piece of equipment and if data sheet is not filled out completely.

1.4 DESIGN CRITERIA

A. Fan ratings shall be tested and certified in accordance with AMCA Standards 211 and 311 and fans shall bear AMCA Seal.

B. Fans shall be furnished complete with motors, wheels, drive assemblies, bearings and accessories as hereinafter specified. Motors for V-belt drives shall be furnished with adjustable rails or bases.

C. Each fan wheel shall be statically and dynamically balanced to Balance Quality Grade G6.3 per ANSI S2.19 and AMCA 204-05. Complete fan assembly shall be factory balanced statically and dynamically in accordance with Standard AMCA 204-05 for Balance Quality and Vibration Levels for Fans and meet or exceed guidelines in Application Category BV-3.

D. For fans furnished with 5 hp or larger hp motors, each fan assembly shall have factory run test including vibration signatures taken on each bearing in horizontal, vertical and axial direction. Filter-in reading as measured at fan's scheduled rpm shall not exceed the following values when fan is rigidly mounted.

1. Belt Drive (except Vane Axial) 0.15 in/sec peak velocity
2. Belt Drive Vane Axial 0.08 in/sec peak velocity
3. Direct Drive 0.08 in/sec peak velocity
4. Written records of run test and vibration test shall be available upon request.

E. Unless otherwise indicated, vibration level of installed fan assembly flexibly mounted shall not exceed 0.35 in/sec

F. Unless otherwise indicated, belt drives shall be V-belt drives selected for 150% of motor nameplate hp.

G. Furnish fans specified with V-belt drives with either variable-pitch or fixed-pitch sheaves for drives 3 hp and smaller and fixed-pitch sheaves for drives 5 hp and larger. Select variable pitch sheaves to drive fan at such speed as to produce specified capacity at approximate midpoint of sheave adjustment.

H. When fixed-pitch sheaves are furnished, system air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. This Contractor shall provide necessary trial and final sheaves and drive belts as required by TAB Contractor.

I. Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

J. Provide OSHA Compliant belt and shaft guards for belt driven fans. Provide speed test openings at shaft locations. Paint guards bright yellow.

K. Sound power levels shall be based on tests performed in accordance with AMCA Standards 300 and 301.

L. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases.

M. Consider drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.

N. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of change and system effect factor calculations indicating increased static pressure requirements as described in AMCA Publication 201. This Contractor shall be responsible for costs associated with any motor, drive, and/or wiring changes required as a result of duct configuration changes at fan.

O. Exhaust fans serving fume hoods shall be marked with arrows to indicate proper direction of rotation.

P. Unless otherwise scheduled, AMCA Type C spark resistant construction shall be used for fans handling flammable or grease laden vapors. Fans having spark resistant construction shall be electrically grounded so as to prevent static electricity from building up.

Q. Fans scheduled with baked phenolic coating shall have internal parts in contact with air stream sand blasted to white metal finish and coated within 24 h. Coating thickness shall be 5 mils minimum, equal to Heresite P-403L (first 3 coats) and L-66L (final 2 coats) with each coat baked separately. Dry film thickness must be verified before final baking. Paint all exterior metal parts with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

PART 2 - PRODUCTS

2.1 MIXED FLOW FANS

A. Manufacturers: Twin City, Greenheck, Chicago Blower, or PennBarry

B. Cook will be acceptable manufacturer provided fans meet requirements specified and scheduled.

C. Housings: Heavy gauge steel with welded fabrication, adequate reinforcing to prevent housing distortion, fully streamlined inlet cones, multiple straightening vanes following fan wheel to redirect air flow to minimize noise and reduce turbulence and flanged inlet and outlet. Fan housings shall be designed to promote straight line, air flow from entrance to discharge.

D. Wheels: Wheels shall be mixed flow type with single-thickness cambered blades. Blades shall be continuously welded to back plate and wheel cone. Wheels shall be statically and dynamically balanced and complete fan assembly including motor and drive shall be test balanced at or near operating speed at factory prior to shipment.

E. Shaft: Fan shaft shall be turned and polished steel and sized so first critical speed is at least 25% over maximum operating speed for each pressure class.

F. Bearings: Air handling quality, heavy duty, grease packed, cast iron, pillow block type with grease seal, furnished with external grease fittings, selected for minimum life (ABMA L-10) of not less than 80,000 h (equivalent to L-50 average life of 400,000 h) at maximum cataloged operating speed. Drives and bearings shall be contained within belt tube, isolating drives completely away from airstream.

G. Painting: Fan parts shall be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.

H. Motor Mounting: Fan motor shall be mounted on adjustable platform appropriate to fan arrangement.

I. Inlet Bells and Screens: Furnish inlet bells and 1” mesh screens for fans shown without inlet ductwork.

2.2 HIGH-PLUME INDUCED FLOW FANS – CENTRIFUGAL WHEEL (LABORATORY EXHAUST)

A. Manufacturers: Strobic, Twin City, Greenheck, or MK Plastics

B. General: Fans shall be airfoil centrifugal induced flow exhaust fans designed for laboratory exhaust duct and suitable for continuous operation. Fans shall be UL/cUL 705 listed. Fans shall include NEMA premium efficiency, TEFC motors. Furnish fans with AMCA Class C spark resistant construction.

C. Performance ratings: Conform to AMCA Standard 210, 260, and 300. Fans shall be tested in accordance with AMCA 210, 260, and 300 in AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300), and induced flow fan for high plume dilution blowers (AMCA 260).

D. Housings: Continuously welded steel, reinforced with rigid bracing. Includes aerodynamically spun inlet cone.

1. Housings with lock seams or partially welded construction are not acceptable.
2. Include threaded drain connection with threaded plug at lowest point of housing scroll.
3. Provide standard shaft seal to reduce leakage and protect the bearings from contaminated airstreams.
4. Provide bolted access door.
5. Provide housing with pre-punched flanges for making connections to ductwork.

E. Induction Nozzle: Air induction discharge nozzle shall be supplied by fan manufacturer, be integral to fan body design, and be designed to efficiently handle outlet velocity of up to 7000 fpm.

F. Wheels: Provide fabricated wheel with airfoil blades, continuously welded to backplate and wheel outer rim. Hub to be keyed to shaft. Wheels shall be statically and dynamically balanced and complete fan assembly including motor and drive shall be test balanced at or near operating speed at factory prior to shipment.

G. Bearings: Air handling quality, heavy duty, grease packed, cast iron, pillow block type with grease seal, furnished with external grease fittings, selected for minimum life (ABMA L-10) of not less than 200,000 hours at maximum operating speed, in accordance with ABMA 9 for ball type, or ABMA 11 for roller type bearings.

H. Shaft: Shaft shall be AISI C1045 hot-rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for first critical speed of at least 1.43 times the maximum speed. Key shaft to wheel hub. Include OSHA compliant shaft and bearing guard.

I. Access Doors: Bolted and gasketed type in fan housing for inspection of interiors and wheel.

J. Fan Isolation Damper: Fan isolation damper(s) shall be parallel-blade design, airfoil design, fabricated of steel for structural rigidity, and coated with a minimum of 4 mils of chemically resistant polyester resin, electrostatically applied and baked.

K. Special Coating: All fan components shall have two part electrostatically applied and baked, corrosion resistant coating equivalent of Heresite P-413C. Coating thickness shall be 6 mils (min), not affected by UV, and have superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 h ASTM B117 Salt Spray Resistance.

L. Painting: All metal parts not coated with special coating shall be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to all exterior surfaces.

M. Direct Drive:

1. Provide coupling with service factor of 1.5-times motor HP between motor and fan shaft.
2. Include OSHA compliant coupling guard.

N. Motor Mounting: Fan motor shall be mounted on adjustable platform appropriate to fan arrangement.

O. Vibration Isolation:

1. Provide welded structural steel vibration isolation base and spring vibration isolators in accordance with fan manufacturer's requirements, and Division 23 0550 – Vibration Isolation.

P. Outlet Sound Attenuator: Provide manufacturer’s 3’-0” outlet sound attenuator matched to fan and induction nozzle suitable for laboratory exhaust service.

Q. Bypass Air Plenum:

1. The plenum shall be double-wall, constructed of insulated welded steel and shall include corrosion resistant coating. Plenum top shall be slopped to allow for drainage.
2. The plenum shall be provided with a factory installed welded steel bottom. The factory shall provide welded duct inlets into the bottom plenum sheet to provide a maximum 1000 FPM inlet velocity into the plenum. The exhaust inlet duct shall extend 2” above the bottom sheet to prevent water in the plenum from running back down into the exhaust duct and be allowed to drain out through the plenum drains. The bottom inlet duct shall extend a minimum 6” below the plenum bottom and have a welded bolting flange. A loose mating flange shall also be provided. No field welding to the fan or plenum is allowed that would damage the protective coating.
3. The bypass air plenum shall be mounted on an insulated curb.
4. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of galvanized steel. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream. Actuators shall be provided by controls contractor.
5. Dampers shall be sized to provide system static pressure control across the entire range of static pressures and exhaust system flow rates. Each individual bypass damper, in the full open position, shall provide a significant fraction of the system pressure in order to be sized properly and provide system control. The size and quantity of outside air bypass

dampers shall be designed to allow for bypass air flow equal to the total flow of one individual exhaust fan at a velocity of 2,000 fpm across all dampers in the full open position.

6. Provide integral bypass air packless acoustic attenuator fabricated of galvanized steel.
7. Fan isolation damper, shall be parallel-blade design, airfoil design, fabricated of 304 stainless steel. Isolation damper(s) shall have stainless steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream. Actuators shall be provided by controls contractor.
8. Plenum shall include a removable bypass air weather hood that is properly sized for low inlet velocity of the bypass air, minimizing the possibility of moisture entrainment.
9. Provide flexible connectors between mixing plenum box and fan inlet.

2.3 TUBULAR CENTRIFUGAL FANS

A. Manufacturers: Twin City, Greenheck, Chicago Blower, PennBarry, or Peerless

B. Cook will be acceptable manufacturer provided fans meet requirements specified and scheduled.

C. Housings: Heavy gauge steel with welded fabrication, adequate reinforcing to prevent housing distortion, fully streamlined inlet cones, multiple straightening vanes following fan wheel to redirect air flow to minimize noise and reduce turbulence and flanged inlet and outlet. Fan housings to be designed to promote straight line, air flow from entrance to discharge.

D. Wheels: Non-overloading airfoil blades welded to wheel cones unless otherwise indicated.

E. Bearings: Heavy duty self-aligning, grease packed, cast iron, pillow block type with grease seal, furnished with external grease fittings, selected for minimum life (ABMA L-10) of not less than 80,000 h (equivalent to L-50 average life of 400,000 h) at maximum operating speed at each pressure class. Drives and bearings to be contained within belt tube, isolating drives completely away from airstream.

F. Painting: Fan parts to be painted with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.

G. Motor Mounting: Fan motor to be mounted on adjustable platform appropriate to fan arrangement.

H. Inlet Vanes: Variable inlet vanes to be furnished for fans as scheduled. Vane bearings to have grease fittings extended to accessible location.

I. Inlet Bells and Screens: Furnish inlet bells and 1” mesh screens for fans specified without inlet ductwork.

2.4 IN LINE DUCT FANS

A. Manufacturers: Twin City, Greenheck, PennBarry, Cook, ACME, Jenn-Air or Carnes

B. Fan housing shall be designed for installation in straight run of duct with transitions as indicated. Housing shall be designed for complete access to fan and motor without removing fan assembly from ductwork.

C. Wheels shall have backward inclined blades. Motor or drive compartment shall be isolated from airstream and be externally ventilated. Bearings shall be prelubricated and sealed and designed for minimum life of 40,000 h operation (ABMA L-10).

D. Paint fan parts with prime coat after metal cleaning and surface preparation. In addition, apply second coat of paint to exterior surfaces.

2.5 POWER ROOF EXHAUSTERS

A. Manufacturers: Twin City, Greenheck, PennBarry, Jenn-Air, Cook, ACME or Carnes

B. Construct housings of spun aluminum.

C. Construct housings of galvanized steel with baked enamel finish; color to be selected by Architect.

D. Exhauster wheels shall be centrifugal, non-overloading type with full inlet cones to reduce air turbulence.

E. Provide units with single phase motors with factory mounted and wired NEMA standard disconnect switches.

F. Units shall be listed and bear UL 705 Label.

G. Mount units on factory installed vibration isolators.

H. Furnish units with bird screens.

I. Provide gravity backdraft dampers for fans when control dampers or motorized dampers are not scheduled or specified.

J. Units shall be furnished with factory fabricated, curb and extended base, as required for mounting minimum of 12” above roof.

K. Curbs shall be constructed of galvanized steel or extruded aluminum with continuous welded corner seams, treated wood nailer, minimum 1-1/2” thick, 3 lb density, rigid mineral fiberboard insulation with metal liner.

L. Units shall be furnished with factory fabricated sound curb as indicated.

2.6 CENTRIFUGAL SIDEWALL EXHAUSTER

A. Manufacturers: Greenheck, Twin City, Cook, PennBarry, Jenn-Air, ACME or Carnes

B. Exhausters shall be dome type with spun aluminum housing, non-overloading centrifugal wheel, and motor housed in separate ventilated compartment.

C. Exhausters shall be belt or direct driven, as scheduled, with factory mounted NEMA standard disconnect switches.

D. Provide with gravity backdraft dampers and birdscreen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and cap discharge of drain.

B. Verify lubrication of motor and fan bearings and lubricate properly in accordance with manufacturer’s recommendation and Section 20 0000, Part 3 under LUBRICATION.

C. General Contractor will install curbs furnished with fans unless otherwise indicated.

D. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Part 1 of this Section.

END OF SECTION 233400

Fan Data Sheet

General

Project	_____
Identification	_____
Service	_____
Location	_____
Type	_____
Manufacturer	_____
Model Number	_____

Performance

Capacity	_____
Efficiency (%)	_____
Brake Horsepower at design flow rate (cfm)	_____
Brake Horsepower at 110% of design flow rate (cfm)	_____

Physical Characteristics

Size	_____
Class	_____
Drive Arrangement	_____
Discharge Rotation	_____
Drive	_____
Bearing	_____

Motor

Manufacturer	_____
Horsepower	_____
Voltage	_____
Phase	_____
Hertz	_____
RPM	_____
Type	_____
Enclosure Type	_____
Frame Type	_____
Insulation Class	_____
NEMA Design Designation	_____
Service Factor	_____
Nominal Efficiency	_____
Nominal Power Factor	_____
Full Load Amps	_____
Variable Frequency Drive Driven (Yes or No)	_____

Miscellaneous

Vibration Isolators	_____
Special Coating (Yes or No)	_____
Special Coating Type	_____

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SECTION 233600 - AIR TERMINAL DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 3114 - Ductwork (Support)

C. Section 23 3314 - Ductwork Specialties (Access Doors)

D. Section 23 8214 - Heating and Cooling Terminal Devices

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Sound rating data
6. Dimensions
7. All other appropriate data

B. LEED Submittal:

1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment.”

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70 by qualified testing agency and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”

1.5 DESIGN CRITERIA

A. Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below. See related work above.

B. When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.

C. Unless otherwise stated, units shall be system pressure independent and maintain air volume within ± 5% of required airflow regardless of system air pressure. Inlet velocity pressure sensor shall be multi-point center averaging type and be capable of amplifying pressure signals.

D. Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 22 ga.

E. Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage.

F. Unit leakage test shall comply with ASHRAE Standard 130 – Laboratory Methods of Testing Air Terminal Units.

G. Unit performance shall be certified in accordance with AHRI Standard 880 including sound rating data certified for both casing discharge and radiated sound levels from 125 through 4000 Hz.

H. Supply air units shall be capable of operating from minimum inlet static pressure scheduled to 3” WG.

I. Air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3” WG inlet pressure.

J. Casing leakage rates shall not exceed the following maximum values:

	Max. Casing Leakage (cfm)	
Unit Size	0.5” WG	1.0” WG
4, 5, 6	2	3
7, 8	2	3
9, 10	2	3
12	2	3
14	2	3
16	3	4

L. Provide supply air units with internal thermal insulation faced with minimum 0.001” thick aluminum foil. Insulation shall be compressed glass fiber with minimum 3/4” thick, 4 lb/ft^3 density with R-value of 3.5[(h·ft^2·°F)/Btu]. Insulation and facing shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), and NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi

Resistance). Secure liner with full-seam-length, galvanized steel angles or Z-strips, which enclose and seal all edges. Tape or adhesive will not be acceptable. Liner assembly shall be similar to Titus Steri-Loc.

M. Supply air units shall be lined with engineered polymer foam insulation, minimum 3/4" thick, 1.5 lb/ft^3 density and thermal conductivity not more than 0.25[$(h \cdot ft^2 \cdot °F)/Btu$] at 75°F. Insulation shall meet requirements of UL 181 (Air Erosion, Mold Growth and Humidity), NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance).

N. Sound attenuators, where specified or required to meet sound performance specified for air terminal devices, shall be constructed of all metal or sound attenuating fiber material with erosion protection liner as required to meet sound requirement specified. Refer to Section 23 3314 - Ductwork Specialties for sound attenuators and erosion protection.

O. Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.

P. Air consumption of each pneumatic control assembly shall not exceed 35 scim (1.2 scfh).

Q. Room sound levels due to discharge and/or casing radiation from units when operating from minimum pressure scheduled to 2" WG inlet static pressure shall not exceed noise criteria (NC) values in any spaces as indicated below. If units exceed sound level specified, provide terminal sound attenuators to comply with the noise criteria stated below. Refer to Section 23 3314 - Ductwork Specialties for sound attenuating devices.

Type of Room	Noise Criteria (NC)
All spaces unless otherwise indicated	35
Computer Rooms	40
Laboratories and Support Spaces	50
Patient Rooms	30
Libraries and Conference Rooms	30

1.6 CONTROLS COORDINATION

A. Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Control Contractor's use.

B. Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by unit manufacturer for unit manufacturer's factory mounting. Unit manufacturer and Control Contractor shall coordinate for proper factory installation.

C. Unit manufacturer shall factory install devices furnished by Control Contractor to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by Control Contractor with units being provided.

D. Unit manufacturer shall perform preliminary calibration based on scheduled airflow rates.

E. Control Contractor shall be responsible for calibrating actuators and controllers through TAB work for scheduled airflow rates.

F. Control Contractor's field mounting will be acceptable, provided Control Contractor coordinates proper installation with unit manufacturer. Control Contractor shall be responsible for complete functioning unit.

PART 2 - PRODUCTS

2.1 VARIABLE VOLUME AIR TERMINAL DEVICES

A. Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Carnes, Tuttle and Bailey, Metalaire, Trane, JCI or Carrier

B. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from hvac control power transformer cabinets to each air terminal device.

C. Units shall be suitable for 20 psi pneumatic control system and shall be normally open on loss of pneumatic pressure. Controller to be reset type with adjustable minimum and maximum setpoints, equal to Titus II Controller.

D. Furnish units with reheat coils having capacities as indicated in schedules.

E. Provide access doors for all air terminal devices with reheat coils at inlet side of coils. Refer to Section 23 3314 - Ductwork Specialties for access doors. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units.

F. Provide access doors for all boxes with reheat coils at inlet side of coils. Reheat coils shall be shipped loose and field mounted. Provide sheet metal connecting section between units and reheat coils for mounting access doors. Refer to Section 23 3314 - Ductwork Specialties for access doors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings and according to manufacturer's installation instructions.

B. Install units with sufficient service space to unit control, actuators and access panels.

C. Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet.

D. Provide access doors for terminal devices with reheat coils at inlet side of coils.

E. Provide access panels compatible with ceiling for all units located above non-accessible ceilings.

END OF SECTION 233600

SECTION 233614 - LABORATORY TEMPERATURE AND AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 01 - Submittal Procedures

B. Section 23 0595 - Air Systems Balance

C. Section 23 0901 - Control Systems Integration

D. Section 23 0902 - Control Valves and Dampers

E. Section 23 3314 - Ductwork Specialties (Sound attenuators and access doors)

F. Section 23 8214 - Heating and Cooling Terminal Devices

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions of the Contract, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 DESCRIPTION

A. This specification is for procurement and installation of laboratory temperature and airflow control system, complete with air terminals, fume hood controllers, fume hood sash sensors, electric/pneumatic transducers, air terminal controllers, master controllers, control wiring, pneumatic tubing, space temperature sensors, and all accessories required, except where otherwise specified, to provide complete and functional system. System shall include all equipment necessary to control fume hoods, exhaust rate, air terminals, and reheat coils as specified in control sequences included in specification Section 23 0993 - Control Sequences, with exception of furnishing and installing reheat coil control valves. Reheat coil control valves to be furnished by Temperature Control Contractor and installed by Mechanical Contractor. Refer to Specification Section 23 0902 - Control Valves and Dampers.

B. Air terminal devices shall be installed in the ductwork system by Laboratory Temperature and Airflow Control System (LTACS) Contractor. Laboratory Temperature and Airflow Control System Manufacturer shall coordinate delivery and installation schedule of air terminal devices with Mechanical and Controls Contractor.

C. Laboratory Temperature and Airflow Control System Contractor shall assist Project Expeditor in preparation of coordination drawings as specified in Section 20 0000 - General Mechanical Requirements. As part of this effort, this Contractor shall provide locations of control components to Project Expeditor, review schedule for preparation of Coordination Drawings as prepared by

Project Expeditor, and attend meetings as required to assist in preparation of documents, and actively participate to resolve layout issues in timely manner.

D. This specification applies to all spaces indicated in Air Terminal Device schedules as having Laboratory air terminals and applies to lab control sequences.

1.4 SUBMITTALS

A. Refer to Division 01 - Submittal Procedures

B. Submit Shop Drawings for all supply, general exhaust, and fume exhaust air terminals, actuators, sash sensors, fume hood controllers/monitors, controllers, master controllers, control wiring, pneumatic tubing, space temperature/humidity sensors and all accessories. Shop drawings shall be complete in all respects and shall include, but not be limited to the following:

1. Manufacturer's printed product data sheets indicating name and model number of all pieces of equipment.
2. Name, address and phone number of supplier
3. Name, address and phone number of local representative
4. Identification as referenced in documents
5. Capacity/ratings and dimensional data
6. Materials of construction and installation requirements

C. Bill of material identifying actual product model number used for each control device for each schematic drawing.

D. Control drawings with graphic representation of system components. Identify controlled devices as referenced on plans with unique valve and damper tag numbers.

E. Electrical characteristics indicate any field wiring which is to be performed by others, type of signal wiring, and installation methods including raceway type and grounding method.

F. Supply and exhaust air terminal certified sound data for both casing discharge and radiated sound levels from 125 through 8000 Hz as tested in accordance with ASHRAE/ANSI Standard 130, S12.12 or AHRI Standard 880.

G. Instrument specifications

H. Controller description

I. System/network architecture configuration diagram showing all controller / control panel types and locations and interconnecting wiring and interface points.

J. Written control sequences describing method of control, alarms, setpoints referenced to tag number of device.

K. Outline drawing showing overall dimension, component location and spacing, and interfacing connections sizes and locations.

L. Identify setpoint or adjustable control range for each control device.

M. Submit Completion Check List as specified in Section 23 0901 - Control Systems Integration.

N. Shop Drawings and complete equipment and software descriptions shall be submitted in sufficient detail to assess equipment's conformance to this specification and physical size of equipment.

O. Organize submittal with table of contents and tabs for each section arranged by logical groups of devices.

1.5 DESIGN CRITERIA

A. Unit manufacturer, or his designated representative, will be required to verify air terminal device performance and adjust or replace device(s) within warranty period when it is determined that problem exists in area served by device(s).

B. Actuators and linkages shall be furnished and factory installed by Laboratory Temperature and Airflow Control Manufacturer.

C. Standard actuator of manufacturer is acceptable provided it meets criteria specified herein.

D. Actuator and its controller shall be calibrated and either factory set or field set through TAB work for scheduled airflow rates. Air terminals shall be capable of field calibration and readjustment with external gauge taps.

E. Air consumption of each pneumatic control assembly shall not exceed 35 scim(1.2 scfh).

F. Refer to Air Terminal Device schedules for definition of minimum inlet static pressure requirement for each air terminal device as well as sizing criteria.

G. Provide all components not specifically indicated or specified, but necessary to make system function within intent of specification and in accordance with control sequences specified in Section 23 0993 - Control Sequences.

H. Size all control apparatus including all air terminals to provide stable control of systems and equipment served throughout specified operating range.

I. Any devices subject to corrosion, such as in fume hood exhaust ducts, shall be provided with appropriate corrosion protection.

1.6 CODES AND STANDARDS

A. All materials and workmanship described herein shall be in accordance with latest edition and addenda of codes and standards listed below:

1. AMCA Air Movement and Control Association
2. AHRI Air Conditioning, Heating, and Refrigeration Institute
3. ASTM American Standards Testing and Materials
4. NEC National Electrical Code
5. NEMA National Electrical Manufacturers Association
6. NFPA National Fire Protection Association
7. UL Underwriters Laboratories

1.7 FCC COMPLIANCE

A. All equipment furnished under this Contract shall have been tested and made to comply with limits for Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environment. Literature shall so note and all equipment shall be so labeled to show this compliance.

1.8 ADJUSTMENT, PERFORMANCE TEST AND CERTIFICATION

A. After completion of installation, regulate and adjust all equipment provided in this contract as outlined in Completion Check List.

B. Conduct complete performance test for all systems to assure compliance with contract documents. Any components on systems found defective or not performing satisfactorily shall be readjusted and retested after necessary corrective measures are performed. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program.

C. Provide written certification signed by applicable person(s) for incorporation in O&M manuals stating date when successful completion of performance tests is achieved. Letter shall verify all controls are installed and software programs have been completely exercised for proper equipment operation.

1.9 WARRANTY

A. Warrant all work, materials, equipment, and controls against defects in workmanship and material per Article 42 of General Conditions and provide service for period of 1 yr from date of final acceptance by Owner.

B. Replace any defective workmanship or material developing within that time as soon as possible at no charge to Owner.

C. After completion of installation, manufacturer shall regulate and adjust equipment provided in this contract prior to final acceptance.

1.10 OWNER TRAINING

A. Laboratory Temperature and Control System Contractor shall have designated representative available to monitor/modify lab control systems after systems have been started and are regularly used until Owner has completed on-site training specified.

B. Provide minimum of 24 hours of on-site training to Owner’s representatives. Conduct training sessions during normal working hours after system start-up and acceptance by owner. Scheduling of training session(s) will be established by Owner and shall include both classroom and hands-on training. Portions of training may be performed before system is completely operational, but no sooner than 1 month before system is planned to be fully operational. Final training session shall be held after systems are complete, including all graphics programming.

C. Training sessions shall include, but not be limited to, the following topics:

1. Explanation of control sequences. Include which sensors are used and how output device operates.
2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3. Walk-through of Project to identify controller locations and general routing of network cabling.
4. Review of operation and maintenance of hardware devices including controllers, instruments, and sensors. Include schedule for routine maintenance.

D. Instructions on how to monitor and operate system hardware and software, and how to change system set points, flow rates, etc and respond to alarms.

E. Review interface for troubleshooting using operator interface device.

F. Training sessions shall be conducted during separate visits to site from site visits for system adjustment, performance test and certification.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements

B. Operating and maintenance manuals shall provide descriptions of maintenance on all system components including sensors and controlled devices. These shall include Control Contractor's completion check list, inspection requirements, periodic preventative maintenance, cleaning methods and materials, troubleshooting guide, calibration instructions and tolerances, repair parts lists, and manufacturer representative's name, address, and phone number.

C. O&M Manuals shall also include interconnection wiring diagrams with identified and numbered system components and devices.

1.12 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements

B. Submit revised Shop Drawings indicating all changes made during project including any changes to operating sequences or setpoints.

C. Update control diagrams to include all tuning parameters and setpoints applicable to systems as depicted as of date of system completion. This information shall be incorporated with sequence of operation of each system.

D. Record actual locations of control components including control units, temperature/humidity sensors, air terminals and any controlled devices on As-Built ductwork/piping plans provided by Mechanical Contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Design of Contract Documents, are based on laboratory temperature and airflow control system as manufactured by Phoenix Controls Corporation. Approved equivalent systems from Critical Room Control (CRC), TEL, or Accutrol that comply with the intent of the contract documents will be acceptable.

2.2 GENERAL

A. Materials shall be new and unused and free from defects and imperfections.

B. Laboratory temperature and airflow control system shall be fully stand-alone for each individual laboratory or laboratory support space. System shall not use or rely on information from controllers in other laboratory areas or from outside laboratory space to control functions within its laboratory.

C. Laboratory airflow control system shall employ individual Average Face Velocity controllers that directly measure area of fume hood sash opening and proportionally control hood's exhaust airflow in variable volume mode to maintain constant face velocity over minimum range of 25 to 100% of full sash opening. Safety and energy savings shall be insured through corresponding minimum change in hood exhaust flow of 4 to 1.

D. Electrically actuated terminal units shall be pressure independent with airflow accuracy of ±5% over airflow range of terminal. Air terminal units shall be balanced to conform to requirements of Section 23 0595 - Air Systems Test Adjust Balance.

E. Laboratory airflow control system shall use volumetric offset to maintain room pressurization. Offset airflow is indicated for each lab on Air Terminal Device schedule.

F. Vertical sash sensor shall be provided to measure height of each vertically moving fume hood sash. Horizontal sash sensor shall be provided for each pair of horizontal or overlapping sashes that are located on horizontal, combination, or walk-in type fume hoods. Operational life of sensors shall be minimum of 250,000 cycles. Sash sensors mounted on fume hood sashes shall extend to within 1/8” or less of the edge of the sash trim edge.

G. Provide an individual fume hood controller for each fume hood, which shall maintain face velocity set point in response to sash position. Controller shall maintain constant average face velocity as fume hood sashes are opened and closed. Controller shall modulate exhaust airflow between minimum and maximum air flow rates scheduled in Air Terminal Device Schedules.

H. Control wiring shall meet requirements of specification Section 23 0901 - Control Systems Integration.

I. Control panels (including routers and power supplies) shall be located near entry to each lab. Coordinate location of control panel with all trades to provide access to panel for maintenance. Provide communications jack as part of or adjacent to space temperature sensor to allow communication between laptop computer and control panel. Provide one control panel for each lab as shown on plans.

J. Provide sound attenuator for each air terminal device. Refer to Section 23 3314 - Ductwork Specialties for sound attenuator specification.

K. Air Terminal Devices - General:

1. Air terminals shall be pressure independent over a 0.3” to 3.0” WG drop across the air terminal. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
2. Airflow accuracy shall be ±5% of airflow (not velocity pressure) over an airflow turndown range of no less than 10 to 1.
3. Provide differential pressure switch mounted across each air terminal or other means to signal alarm under low flow condition at each fume hood.

L. Supply and General Exhaust Air Terminals:

1. Air terminals for non-corrosive airstreams, such as supply and general exhaust air, shall be constructed of 16 ga aluminum. The air terminal shaft and shaft support bracket shall be made of 316 stainless steel. The pivot arm and internal mounting brackets shall be made of a combination of aluminum and stainless steel. The pressure independent springs shall be of combination 302 and 316 stainless steel. All shaft bearing surfaces shall be made of a Teflon or Celenex composite.
2. Provide external insulation of each supply air terminal device with 3/8” minimum fiber-free closed cell insulation by manufacturer.

M. Fume Exhaust Air Terminals:

1. Air terminals for corrosive airstreams, such as fume hoods, biosafety cabinets, snorkel, flammable storage cabinets and equipment exhaust shall have the following construction:
   a. Valve body and cone: Baked phenolic coated aluminum
   b. Shaft: Teflon coated 316 SS
   c. Shaft support brackets: Baked phenolic coated 316 SS
   d. Spring: Baked phenolic coated 302/304 SS
   e. Pivot arm: Baked phenolic coated 316 SS

N. Air Terminal Actuators

1. Electric actuator shall be factory mounted to air terminal. Loss of control power shall cause exhaust air terminals to fail open to maximum scheduled design flow and supply air terminals to fail to minimum scheduled design flow.

O. Certification

1. Each air terminal shall be factory calibrated to job specific airflows as detailed on plans and specifications using NIST traceable air stations and instrumentation having combined accuracy of at least ±1% of signal over entire range of measurement.
2. Air terminals shall be individually marked with air terminal specific model number, and quality control inspection numbers. Information shall be stored on computer CD diskette in ASCII Format by manufacturer for future retrieval or for hard copy printout to be included with as-built documentation.

P. Air Terminal Controllers:

1. Controller shall use electronic-based, closed loop control to regulate airflow.
2. Response time to vary air terminal's airflow to within 90% of its commanded setpoint value shall be no more than one (1) second with less than 5% undershoot or overshoot.

Q. Laboratory Temperature and Airflow Control System :

1. Controller(s) mounted on supply or exhaust air terminal(s) with interfaces with control devices shall control the supply and/or general exhaust air flow air terminal devices to maintain proper room pressurization polarity (positive or negative). Each laboratory suite shall have a dedicated sub-network defined by tracking pairs supply, general exhaust, and fume exhaust valves where applicable.
2. The supply/exhaust terminal controllers shall be microprocessor-based digital controllers. They shall control and communicate digitally via BACnet MS/TP Communication Protocol to provide air flow control within a particular pressurization zone.
3. The supply/exhaust terminal controllers shall maintain a constant design offset between the room exhaust and make-up/supply air flows. This offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from adjacent spaces.
4. Terminal controllers shall provide an EIA-232 port for connecting a notebook computer, desktop computer, modem, or alarm printer. This EIA-232 port shall provide access to all points of the network.
5. Terminal controllers shall accommodate sufficient point to address temperature control and non-network sensors.
6. Routers shall have the capability for full stand alone operation and shall be capable of communicating digitally with up to 100 routers or network devices over a secondary high-speed building wide digital laboratory control system digital network.
7. Routers shall be panel mounted in a NEMA enclosure and shall operate on 24 V AC power. Mount 24 V AC transformers for the routers in an enclosure that is accessible or adjacent to the routers.
8. All network components shall meet FCC Part Subpart L Class A, and be UL 916 listed.
9. The supply air terminal controller shall provide control signal to reheat coil control valve to maintain space temperature. Provide devices as required to interface with electronic control of reheat coil control valves. Refer to Specification Section 23 0901.

R. Fume Hood Controller:

1. Provide for each fume hood an individual fume hood controller, which shall maintain face velocity setpoint (adjustable) in response to sash position. Controller shall maintain constant average velocity as fume hood sash is raised and lowered, or moved horizontally. The controller shall calculate average face velocity from exhaust cfm and hood open area. This face velocity is compared to the setpoint to calculate the required exhaust air flow. The actual airflow must be measured and used for control.
2. Controller shall be UL 916 Listed.
3. Controller shall support fume hood sash configurations utilized in this project. Coordinate with fume hood manufacturer.
4. Initial setpoint for face velocity shall be 80 fpm with 18" sash open height for all hoods.
5. Provide general alarm output for use with auxiliary devices.
6. Momentary or extended losses of power shall not change or affect any of control system's setpoints, calibration settings, or emergency exhaust mode status. After power returns system shall continue operation exactly as before without need for operator intervention. Under no circumstances shall loss of power command exhaust system to full flow upon return of power.

S. Fume Hood Monitor:

1. A FHM 430-ENG fume hood monitor shall be provided for each fume hood to comply with laboratory safety standards. Standard Operation: Fume hood is operating within acceptable tolerance levels (Face Velocity = SETPOINT ±15%)
2. Standby Operation: (Setback feature based on hood zone presence sensor OR time of day is when configured into system)
3. Caution/Low Flow Alert (also triggers integral audible alarm) as derived by:
   a. Insufficient exhaust static pressure as indicated by PDS (integral to controller) across VEV-(*) Static Pressure < 0.15 kPa (0.6" WC).
   b. Inferred air flow (as indicated by integral actuator position feedback sensor) does not match controller output.
   c. Emergency Exhaust Alert (also triggers integral audible alarm): hood is operating in Emergency Exhaust Mode as initiated by integral Emergency Exhaust pushbutton on FHM.

4. Device shall provide the following control functions:
   a. Alarm mute: Integral pushbutton to silence the audible alarm except during emergency purge mode. During a non-emergency mode, the audible alarm shall re-activate if it has not cleared after a 10 to 15 minute period from the Alarm mute button being pressed.
   b. Emergency Exhaust: Integral pushbutton to command exhaust valve VEV-(*) 100% open.
   c. There shall be no local indication of face velocity.

T. Room Temperature Sensors:

1. Sensors shall be 10K ohm thermistor type by Automation Components, Inc. (ACI) or Building Automation Products Incorporated (BAPI). Thermistor shall incorporate jumpers and RJ-11 connector specific to the “Phoenix” option. Sensor shall include communication jack to allow remote programming via laptop computer. Temperature sensors shall have remote sensor located in room general exhaust duct and adjustable setpoint adjustment and temperature adjustment in wall enclosure for each laboratory or laboratory support space and shall be programmable with adjustable deadband set point between 72°F and 78°F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install fume hood monitors and sash sensors at each fume hood. Coordinate installation requirements with fume hood manufacturer.

B. Install units as shown on drawings, schedules and details. Coordinate with Mechanical Contractor to verify appropriate ductwork configuration to allow for accurate measurement and control of airflow.

C. Laboratory Temperature and Airflow Control System manufacturer shall furnish, install and terminate all low voltage control wiring and 24 VAC power supplies. Laboratory Temperature and

Airflow Control System manufacturer shall furnish and install pneumatic control tubing required for laboratory control devices that are pneumatically operated.

D. Air Terminals and Reheat Coils:

1. Laboratory Temperature and Airflow Control System Contractor shall furnish to Mechanical Contractor to install air terminals, sound attenuators, reheat coils and access doors as shown on drawings and according to manufacturer's instructions. Mechanical Contractor shall install reheat coil control valves furnished by Temperature Control Contractor. Mechanical Contractor shall provide necessary ductwork transitions as required for mounting equipment provided by LTACS Contractor.
2. Mount actuators on same side of air terminal device as coil connections to ensure service access.
3. Connect air terminals to ductwork with removable type joints as detailed.
4. Transition from supply air terminal to reheat coil shall not exceed 15° per side.
5. Provide access doors for supply air terminals with reheat coils. Mount access door at inlet side of coil. Refer to Section 23 3314 - Ductwork Specialties for access door requirements.

E. Fume Hood Controls:

1. Furnish to fume hood manufacturer templates for required hood mounted devices including vertical and horizontal sash sensors, interface boxes, and fume hood monitors required for complete installation of fume hood exhaust air control system. Fume hood manufacturer shall provide necessary cut outs with blank cover plates.
2. Fume hood size and sash configuration are called out in Lab Furnishings documents. Verify with fume hood manufacturer fume hood sizes, sash configurations and installation requirements for each device.
3. Laboratory Temperature and Airflow Control System manufacturer shall field install, mount and wire required hood mounted devices.

F. Control and Power Wiring:

1. Laboratory Temperature and Airflow Control System (LTACS) manufacturer shall provide control wiring from laboratory control panel to and between other laboratory control system components as required for complete and proper functioning, including but not limited to air terminals, control valves, sensors, transducers, controllers, panels, and interface modules.
2. Electrical Contractor will provide one spare 20 A circuit at each emergency power electrical panel, serving laboratory. LTACS supplier shall provide required conduit, wire, junction boxes, disconnect switches and circuit breakers as specified in Division 26 as required to wire electrical panel to each laboratory control panel.
3. LTACS supplier will provide power wiring to routers and terminal controllers in each laboratory suite.

G. Laboratory Control Panels and Power Supplies:

1. Mount laboratory control panels and power supplies in accessible location within laboratory room as shown on plans.
2. Coordinate location of electrical power panels with Division 26 Contractor.

H. Laboratory Control System Start-up:

1. System startup shall be provided by factory authorized representative of system manufacturer.
2. Coordinate timing of start-up with Mechanical Contractor to confirm HVAC Systems are operating as specified.
3. Startup shall be performed on complete laboratory temperature and air flow control system and shall include calibration of each laboratory control system component; check out of air terminals, actuators, fume hood sash sensors, temperature sensors, and verification that each system operates in compliance with specified control sequences.
4. Laboratory Temperature and Airflow Control System manufacturer shall measure and set up fume hood average face velocity. Coordinate with and work in conjunction with TAB Contractor.
5. Laboratory Temperature and Airflow Control System manufacturer shall set up system supply, general exhaust, and fume exhaust air flows in cooperation with TAB Contractor. TAB Contractor will take required air flow measurements.
6. Laboratory Temperature and Airflow Control System manufacturer shall provide a visual demonstration that the laboratory airflow systems are maintaining specified hood containment performance requirements. If the performance requirements cannot be demonstrated, then system supplier shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.
7. Laboratory Temperature and Airflow Control System manufacturer shall demonstrate that, with specified room offset, system maintains proper room directional air flows under both static and dynamic operating conditions, and can recover to proper flow direction within one second of change in room/system conditions such as raising and lowering of any hood sashes. Verification shall be provided by temporary visual indication, using smoke wand. If performance requirements can not be demonstrated, then laboratory control system manufacturer shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.

END OF SECTION 233614

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SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.2 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the Documents
3. Capacities/ratings
4. Materials of construction
5. Sound ratings
6. Dimensions
7. Finish
8. Color selection charts where applicable
9. Manufacturer's installation instructions
10. All other appropriate data

1.3 DESIGN CRITERIA

A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70-2006.

B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Titus, Price, Carnes, Nailor, Anemostat, Metalaire, or Krueger

B. Acceptable manufacturers for specialty products are listed under each item.

2.2 CEILING DIFFUSERS

A. Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, and furnished with frame type appropriate to installation. Furnish diffusers with equalizing grids where it is not

possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked enamel or powder coat finish with white color or color selected by Architect.

C. Perforated face ceiling diffusers shall have minimum 51% free face area and pattern controllers accessible through removable or hinged faceplate. Unless otherwise indicated, pattern controllers shall be curved vane type mounted in neck of diffuser. Unless otherwise indicated, furnish diffusers with round neck inlets with minimum 1” depth.

2.3 ARCHITECTURAL SQUARE PANEL CEILING DIFFUSERS

A. Architectural square panel ceiling diffusers shall be similar to Titus Model OMNI diffuser.

B. Diffusers shall have one piece 18 ga face panels. Face panel shall be removable by means of four positive locking posts. Exposed surface of face panel shall be smooth, flat, and free of visible fasteners and have rounded off corners. Face panel shall project no more than 3/8” below outside border of diffuser back pan. Back of face panel shall have an aerodynamically shaped, roller edge to ensure tight horizontal discharge pattern.

C. Ceiling diffusers with 24” x 24” full face shall have no less than 18” x 18” face panel size.

D. Back pan shall be one piece die-stamped and shall include integrally drawn round inlet. Diffuser back pan shall be constructed of 22 ga steel. Diffuser neck shall have minimum of 1-1/4” depth available of duct connection. Back pan shape with face panel shall deliver 360° radial horizontal air pattern.

E. Unless otherwise indicated, diffusers shall have baked enamel or powder coat finish with white color or color selected by Architect.

2.4 REGISTERS AND GRILLES

A. Registers and grilles shall be aluminum or steel as scheduled unless otherwise indicated, and furnished with frame type appropriate to installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Return and exhaust registers and grilles shall have fixed blade core.

D. Registers shall be furnished complete with opposed blade volume control dampers, operable from face.

E. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Architect.

2.5 ADJUSTABLE LINEAR DIFFUSERS

A. Linear diffusers shall be extruded aluminum and furnished with frame type appropriate to installation with diffuser elements being removable from frame. Diffuser vanes shall provide both air pattern and flow rate adjustment with air pattern having full 180° adjustment. Diffuser vanes of single slot shall be segmented on 2 ft or 3 ft centers.

B. Diffuser models, lengths and slot sizes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, frame face shall have baked enamel or powder coat finish with color selected by Architect. Diffuser vanes and frame interior shall be finished in flat black.

2.6 FIXED BLADE LINEAR DIFFUSERS AND GRILLES

A. Linear diffusers and grilles to be extruded aluminum with frame type appropriate to sidewall, sill or ceiling installation as indicated.

B. Diffuser and grille models, lengths, blade spacing and blankoff strips to be as shown on drawings and/or as scheduled.

C. Diffusers used for supply air to be furnished with straightening or equalizing vanes. Blades to be fixed at 0 or 15° deflection as scheduled.

D. Unless otherwise indicated, diffusers and grilles shall have anodized aluminum finish with color selected by Architect.

2.7 RADIAL CEILING DIFFUSERS

A. Diffuser shall be perforated, radial pattern diffuser with directional blades equal to Titus Tri Tec as scheduled.

B. Diffusers shall have flat or dome faced as scheduled.

C. Diffusers shall provide non-aspirating radial air pattern. Units shall be configured with air supply plenums with inlet collars to assure uniform discharge velocity over faces of units.

D. Diffusers shall be 304 stainless steel face with aluminum back pan or 304 stainless steel face and back pan as scheduled.

E. Diffusers shall be tested in accordance with ASHRAE Standards 70-91 and 113-90.

2.8 WIRE MESH GRILLES OR SCREENS

A. Grilles shall be 2 X 2 mesh (1/2”) galvanized steel or aluminum hardware cloth in spot welded galvanized steel frame with 1-1/2” width.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes.

C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.

D. Support independently diffusers and grilles designed for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.

E. Unless otherwise shown, provide wire mesh screen at end of each open-ended duct (OED) that is exposed in occupied spaces.

F. Blank off unused portion of linear diffusers and grilles.

G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

H. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.

END OF SECTION 233713

SECTION 234114 - FILTERS

PART 1 - GENERAL

1.1 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.2 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the Documents
3. Capacities/ratings; cfm, area, face velocity
4. Efficiencies and initial/final pressure drop
5. Materials of construction
6. Dimensions
7. Filter gauges data
8. Manufacturer's installation instructions
9. All other appropriate data

1.3 DELIVERY, STORAGE AND HANDLING

A. Ship filters in original package to prevent damage or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer’s recommendations. Provide protective coverings during construction.

1.4 DESIGN CRITERIA

A. Filters shall have UL 900 Listing.

B. Holding frames or housings specified in this Section may be furnished by filter manufacturers listed below, or where applicable, as part of factory packaged air handling units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Air Filter, Camfil/Farr, Flanders Precisionaire, Glasfloss, Airguard or Filtration Group unless otherwise noted under individual filter.

2.2 DISPOSABLE PANEL FILTERS

A. Similar to Camfil Farr 30/30 or Flanders Precisionaire PrePleat 40.

B. Media shall be non-woven, fine fibered material laminated to rigid backing to hold pleat formation, having minimum efficiency MERV 8 based on ASHRAE Test Standard 52.2 (average dust spot efficiency of 30 to 35% based on ASHRAE Test Standard 52.1).

C. Filter housing shall consist of air handling or cabinet fan unit manufacturer's low velocity filter section, or holding frame, as scheduled. When holding frame is indicated, it may be furnished by filter manufacturer or it may be contractor fabricated.

D. Filters shall be 2” thick of size and capacity as scheduled. Clean filter pressure drop shall not exceed 0.31” WG based on 500 fpm face velocity.

2.3 DISPOSABLE RIGID CARTRIDGE TYPE AIR FILTERS

A. Similar to Camfil Farr Durafil ES RIGA-FLO or Flanders Precisionaire

B. High performance deep pleated, rigid, disposable type filters. Each filter shall consist of high efficiency media, enclosing frame, contour stabilizers on both air entering and exiting sides and support grilles. Filters shall be designed to withstand minimum differential pressure of 6” WG without structural damage to filter frame, seals or media.

C. Filter thickness, size and capacity shall be as scheduled.

D. Filters shall have minimum efficiency MERV 13 based on ASHRAE Test Standard 52.2 (average efficiency of 80-90% based on ASHRAE Test Standard 52.1). Initial resistance at 500 fpm face velocity shall not exceed 0.50” WG.

2.4 ADDITIONAL FILTER MEDIA

A. For disposable panel filters, enough media for 3 filter changes, shall be provided for each air handler. Media used during construction shall be replaced when system is air balanced. Third set of media not used shall be turned over to Owner as spare.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filters as shown on drawings and according to manufacturer's instructions.

B. Provide supports as required and necessary clearance for changing filters.

C. Provide structural supports, outside casing and blank-off materials for all field assembled filter banks, and filter banks where housings are not furnished by filter manufacturer.

END OF SECTION 234114

SECTION 235100 - SMOKESTACK, BREECHING AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name
2. Pressure/temperature ratings
3. Materials of construction
4. Dimensions and weights
5. Thermal characteristics
6. Erection and supporting methods
7. Finish
8. Manufacturer's installation instructions
9. All other appropriate data

B. Submit the following information for welded sheetmetal ductwork:

1. Welding Procedure Specification (WPS) for welded joints. Form to be similar to ANSI/AWS D9.1-90 Code, Appendix "D".
2. Procedure Qualification Record (PQR) for each WPS. Form to be similar to ANSI-AWS D9-1-90 Code, Appendix "E".
3. Welder Qualification Test Record (satisfactory performance) for each field or shop welder. Form similar to ANSI/AWS D9.1-90 Code, Appendix "F".
4. Quality Assurance/Quality Control (QA/QC) program.

1.4 DESIGN CRITERIA

A. All products, fabrication and installation shall comply with requirements of NFPA 211 together with State and Local Codes.

PART 2 - PRODUCTS

2.1 FACTORY-BUILT BOILER VENT SYSTEM FOR CONDENSING BOILERS

A. Manufacturers: Metal-Fab, HeatFab, ProTech Systems or Schebler equal to HeatFab SAF-T Vent or SAF-T CI Vent

B. Smokestack shall be factory-built double wall type with minimum 5/32” air space between walls. Stack shall be listed by UL 1738/ULS S636 listed for continuous operation at 550°F.

C. Inner pipe shall be AL-29-4C superferritic stainless steel in 0.015” minimum thickness for sizes through 12” ID and 0.024” minimum for sizes over 14” through 24” ID.

D. Outer jacket shall be Type 304 or Type 430 stainless steel.

E. Provide stack system complete with all necessary accessories including flashing, counterflashing, storm collar, ventilated roof thimbles, fitting, cleanout and drain section, base anchor lugs and necessary supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install stack, breeching, vents and expansion devices as shown on drawings, details and in accordance with manufacturer's recommendations. Coordinate carefully with General Contractor.

B. Support breechings adequately from building structure with provisions for breeching expansion and contraction.

END OF SECTION 235100

SECTION 235214 - PRIMARY HEATING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 2118 - Valves (Safety Valves, Safety Relief Valves, Blowdown Valves)

B. Section 23 5100 - Smokestack, Breeching and Vent Piping

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Dimensions and weights
6. Temperature/pressure ratings
7. ASME Construction and Stamp
8. Wiring diagrams
9. Manufacturer's installation instructions
10. All other appropriate data
11. Boiler boil-out procedures

B. Complete equipment data sheet attached at end of this Section for each piece of equipment and submit with Shop Drawings. Shop Drawings will be returned without review if data sheets are not provided for each piece of equipment and if data sheet is not filled out completely.

1.4 CERTIFICATES

A. Secure all registration and installation permits required by State and Local Authorities and complete these requirements before system is placed in operation.

1.5 REFERENCE STANDARDS

A. Boilers shall be constructed, tested and stamped in accordance with the latest ASME Boiler and Pressure Vessel Code and must receive authorized boiler inspection in factory.

B. Boiler under 12,500,000 Btuh input: Boilers shall be constructed, installed and tested in accordance with ASME CSD-1 2009, Controls and Safety Devices for Automatically Fired Boilers.

1.6 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide services of factory trained field representative to approve installation; start-up, test and adjust for proper operation; and instruct and train Owner's representative in operation and maintenance of equipment.

B. Upon completion of this service, submit complete report, signed by manufacturer's service representative, including start-up and test log.

C. In addition, submit the following flue gas analysis for boilers.

1. % oxygen
2. % carbon dioxide
3. % carbon monoxide
4. stack temperature
5. % combustion efficiency

D. These readings shall be through entire firing ranges.

E. If boilers are specified for multiple fuels, perform above services for each fuel specified.

1.7 STARTUP, TESTING, TRAINING, AND OPERATION AND MAINTENANCE DATA

A. Boilers:

1. General:
   Boiler manufacturer shall provide services of factory-trained field representative/technician to approve installation, oversee boiler boil-out, conduct start-up, test and adjust for proper operation, pre-test, conduct witnessed testing, and instruct and train Owner’s representative in operation and maintenance of equipment. Boiler manufacturer shall submit résumé for representative/technician(s) actually conducting these services. Representative/technician(s) shall have at least 5 yrs of experience commissioning low NOX systems. All procedures shall be conducted for each boiler and the integrated boiler system as specified herein.
2. Boiler Startup:
   Boiler manufacturer’s representative shall conduct startup of boilers per manufacturer’s recommended startup procedures. Startup shall include the following in addition to manufacturer’s recommended startup procedures:
   a. Complete inspection of installation and boiler condition
   b. Fireside and waterside inspections
   c. Verification of installation of field installed components, connections, wiring, and mountings. This verification shall include remote-mounted burner controller panel and interconnections to boiler skid components, VFD installation, O2 trim panel and all interconnections to boiler skid package, and stack sensors. Verify that control panels are at mounting height allowing easy readability, access, and keyboard manipulation from floor level.
   d. Verification of boiler mounting to achieve seismic restraint and allow for boiler thermal expansion

e. Verification and sealing of doors, manways, hand holes, and all other openings
f. Verify operation and water/steam tightness of all manual valving including blowdown valves, shut-off valves, bypass valves, stop check valves, check valves, warmup valves, and free blow valves
g. Verify strainers are clean and watertight
h. Setup of gas and fuel trains
i. Setup of combustion air system including complete VFD setup
j. Setup of all operating parameters

3. Boiler Pre-Testing:
After startup is complete, boiler manufacturer's representative shall conduct testing of boiler functional operations per manufacturer's recommended testing procedures. All testing shall require detailed, written procedures and shall be submitted to Engineer for approval prior to testing. All testing shall be witnessed by General Contractor's Test Engineer. Boiler manufacturer's representative shall provide all temporary testing equipment and instrumentation required for commissioning. Testing shall include the following in addition to manufacturer's recommended test procedures:
a. Coordinate and assist Building Automation System (BAS) Contractor and/or third-party integrator in installation and verification of all boiler controls/DDC controls interface functions. Testing shall not be considered complete until all interface functions are verified to operate correctly.
b. Verify operation of all boiler safeties including gas limits, oil limits, flame safeguards including timings, low water cutout, auxiliary low water cutout, proof of air pressure/flow, high limits, relief valves, indication of correct fault messages/codes at boiler controller, indication correct alarm reporting through communications to BAS, etc.
c. Verify operation of combustion process for each fuel including timings.
d. Verify operation of feedwater system including interface controls/functions with deaerator feedwater pumps.
e. Testing of boiler combustion air/fuel ratios and emissions analysis throughout firing range and for each fired fuel. Flue gas analysis report shall include measurements of the following throughout the firing range:
1). % oxygen
2). % carbon dioxide
3). % carbon monoxide
4). stack temperature
5). % combustion efficiency
6). NOX ppm
7). SOX ppm
f. Verification of boiler turndown for each fired fuel.
g. Verification of boiler efficiency per ASTM PTC 4.1 procedure with conditions of 125 psig produced steam and 225°F boiler feedwater.

4. Final Report:
a. Upon completion of these services, boiler manufacturer's representative shall submit complete report, signed by manufacturer's service representative, including start-up and test log. Final test report shall include reports for all commissioning tests and procedures. Final completed commissioning functional test procedures shall be signed-off from manufacturer's technician and Contractor's testing representative for each witnessed function.

5. Owner Training:

a. Provide 40 h of training on-site as scheduled with Owner. Provide 2 additional 16 h training sessions at a later date to be scheduled with Owner. Training shall be for up to 8 people. Training shall include basic system descriptions and operations, safety procedures, maintenance procedures, controls functions and operations, and diagnostic/trouble-shooting procedures.

6. Operation and Maintenance Manuals:
   a. Provide Operation and Maintenance (O&M) Manuals including cut-away drawings of boilers, boiler piping diagrams including fuel trains, complete boiler electrical wiring diagrams with interface points, controls sequences and schematic diagrams with interface points, component cut-sheets, complete spare parts lists, maintenance procedures/intervals, inspection procedures, safeties testing procedures, and trouble-shooting procedures.

1.8 COORDINATION

A. Design and drawings are based on one of acceptable manufacturers listed in this Specification. Where requirements of equipment provided differ from equipment on which design is based, this Contractor shall be responsible for coordinating requirements of equipment with other Contractors involved.

B. This Contractor shall be responsible for any additional cost incurred due to such requirements.

1.9 WARRANTY PERIOD FOR FIRE-TUBE CONDENSING BOILERS

A. Provide 1 yr non-prorated parts warranty on all burner components

B. Provide 10 yr non-prorated heat exchanger warranty for failure due to thermal stress and corrosion. Failure due to improper water treatment is not covered in this warranty.

C. Warranty period begins at the date of equipment startup.

PART 2 - PRODUCTS

2.1 HOT WATER BOILER-BURNER UNITS (CONDENSING TYPE)

A. General

1. Provide four (4) packaged fire-tube condensing type hot water boiler-burner units. Units shall be one of the following manufacturer's models with capacity and operating characteristics indicated on schedules: Buderus, Fulton, Viessman, and Parker.
2. Furnish units complete with boiler, burner, forced draft fan, combustion and safety controls, wiring, insulated jacket, boiler trim, drain valve, and assembled on structural steel base frame. Unit shall be ready for connection to fuel, electrical sources, and water piping.

B. Boiler

1. Boilers shall be constructed and stamped in accordance with the latest ASME Code for 60 psig working pressure and must be inspected by Authorized Boiler Inspection Agency and registered with National Board.
2. Heat Exchanger: Type stainless steel on all passes in contact with flue gases.
3. Combustion chamber shall be sealed and completely closed with ceramic fiberboard insulation.
4. Boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory (www.ahridirectory.org) for natural gas operation. Boiler shall operate at minimum 87% thermal efficiency at 120°F return water temperature when fire tested at 100% of rated capacity and at a minimum of 93% thermal efficiency at 120°F return water temperature when fire tested at 25% of rated capacity.
5. Boiler shall have no minimum return water temperature when firing on natural gas and shall be capable of operating in condensing mode. When firing on No. 2 fuel oil, the minimum return water temperature shall be 140°F and the boiler flue gasses shall not condense.

C. Burner

1. Dual fuel forced draft burner shall be manufactured by Riello or Weishaupt.
2. The boiler shall be designed to operate on No. 2 fuel oil using the same burner as is used for natural gas firing. The boiler shall achieve full rated input capacity on the backup fuel. The boiler's flame programmer shall have two independent load profiles, each profile programmed for a specific fuel.
3. Forced draft, pressure atomizing flame retention head dual fuel burner, No. 2 fuel oil, and natural gas, integral motor and blower.
4. Burner shall provide 10:1 turndown on gas (assuming 2psig gas pressure) and 3:1 turndown on oil when encompassing the VFD option. (verifying on all sizes)
5. Burner shall operate throughout entire modulating range with 15% – 20% excess air- 3% O2 from 20%-100% firing rate for maximum combustion efficiency.
6. Sound rating of burner shall not exceed 85 dBa when measured at 3 feet from burner.
7. Burner shall provide less than 40 ppm NOx with less than 50 ppm CO on natural gas and less than 100 ppm NOx with less than 50 ppm CO on No. 2 fuel oil.
8. Burner shall be equipped with hinged head mount that allows for full access to burner drawer assembly without removing the burner chassis from boiler.
9. All fuel trains and controls shall conform to UL requirement, CSD-1 code, be designed in accordance with FM, and be factory assembled, wired, mounted, and tested.
10. Gas pressure to burner will be 2 psig. Unit manufacturer shall provide pressure regulators at burners to reduce pressure suitable to burner operation.

D. Burner Ignition System

1. Gas ignition system for main gas shall utilize natural gas as fuel source. Gas pilot system components shall include spark ignited pilot assembly, 7000 Volt ignition transformer, pilot safety shut off valve, pilot gas pressure regulator and manual gas shutoff cock.
2. Burner oil ignition system shall be by separate 2 x 5000 Volt direct spark ignition system. Burner oil ignition shall be by natural or LP gas pilot if required per UL795 based on burner capacity.
3. Additional Safeties
   a. Manual reset low and high gas pressure switches
   b. Manual fuel selector capabilities in Linkageless controller.
   c. Siemens LMV electronic combustion safety control with UV sensor.

4. Fuel/Air Ratio Control

a. Burner must be outfitted with an integral linkageless fuel/air control system. The system shall be capable of providing adjustable and accurately repeatable constant fuel/air ratio or linearly adjusted fuel/air ratio throughout the burner's firing range. Each system shall be complete with independently electronically adjustable set-points.
b. The boiler shall not require a compressed air supply to fire on No. 2 fuel oil.
c. There shall be no linkage arms on the burner to ratio fuel and air. Direct coupled servo motors with multiple individually adjustable programming points shall be mounted on gas valve, oil valve, and air damper.
d. Burner shall be equipped with variable frequency drive on blower motor.
e. Temperature/Pressure Controller: Controller shall be PID type for accurate control. The controller shall be microprocessor based with UL, CSA, and CE approvals.
f. The servomotor shall perform the following:
    1). Shut down position (damper positioned closed at 0^0 when the call for heat is satisfied)
    2). Independent gas ignition position
    3). Low fire gas position
    4). High fire gas position
    5). Independent oil ignition position
    6). Full modulation gas positions
    7). Full modulation oil positions.
    8). Servomotor motors must be adjustable to any setting from fully closed to fully open.
    9). Servomotor shall provide auto position recognition.
    10). When the operating control is satisfied the burner shall shutoff and return to the closed position. The modulating motor shall provide an electrical interlock to insure a guaranteed low fire start.

E. Electrical and Controls

1. Unit to be furnished with electrical entrance cabinet, NEMA 1, to accept single service of 480 V, 3 Ph, 60 cycle power to accommodate motors and control circuit power. Furnish unit with control cabinet, NEMA 1A enclosure with lock and exterior resets for blower motor starter and flame failure.
2. Boiler manufacturer shall furnish remote shutdown disconnect switch. Switch shall be red mushroom button or Push-to-Activate type with safeguard feature against tampering and easily readable identification marking.
3. Furnish unit with control cabinet, NEMA 1 enclosure with lock and exterior resets for blower motor starter and flame failure.
4. Control cabinet to include magnetic motor starters with thermal overload protection, electronic flame safeguard, programming timer for pre-purge and post-purge, burner switch, control circuit switch and fuse, necessary switching relays, low water and flame failure alarm, manual automatic selector switch, indicating lights for major operations, numbered terminal strips, numbered wiring and engraved nameplates.
5. Controls shall include high limit (manual reset), operating limit (auto reset), frost control, high and low gas pressure switches, blocked condensate drain switch and combustion air switch.
6. Control to be interlocked to cause 100% automatic shut-off of fuel flow to burner in event of failure of electric power, burner flame, pilot flame, low water, combustion air, or any other condition, which might prove hazardous.
7. Furnish unit with all necessary controls for fully-modulated firing with proved low fire start.
8. Provide controls to restart automatically on emergency power or power restoration after power outage.

9. Provide auxiliary contacts to provide status and alarm indication to Building Automation System (BAS). Alarm condition shall be reported to BAS whenever alarm condition is indicated at boiler packaged control panel.
10. Provide terminals to interlock boiler with combustion air fan to prevent burner operation unless combustion air fan is operating.
11. System shall be provided with a communication interface card to communicate via interface with the Building Automation System. Boiler provider and Control Contractor responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems.
12. Furnish unit with lead-lag sequence control panel with selector switch, capable of controlling up to four boilers.
    a. Control shall include assured low fire cutoff.
    b. Furnish temperature sensor required for boiler capacity control required for lead-lag control.
    c. Boiler controls shall sequence lead-lag boilers in response to flow sensor, located in hot water supply header. Operating boilers shall be controlled to maintain supply water temperature setpoint of 130°F (FA). Boiler lead-lag controller shall attempt to operate as many boilers as possible any load. Boilers shall be staged on, operating in parallel or sequential mode to maintain hot water supply temperature setpoint. When a lag boiler is sequenced on or off it shall open or close its associated isolation valve.

F. Insulation and Jacket

1. Units shall be factory insulated with enameled steel jacket.

G. Venting

1. Refer to Section 23 5100 – Smokestack Piping for vent requirements.

H. Boiler Trim (Each Boiler)

1. Furnish complete water trim including:
    a. ASME Safety Relief Valve set at 60 psi
    b. Combination pressure-temperature gauge
    c. Operating temperature controls
    d. High limit control
    e. Low Water Cut Out - LWCO to be operationally testable
    f. Stack thermometer
    g. Air pressure switch
    h. Water flow switch
    i. High gas pressure switch
    j. Low gas pressure switch
    k. Blocked condensate drain switch
    l. Modulating control valve
        1). Valves to be furnished with open and closed position indicators relaying to boiler controller and ultimately available to BAS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on plans, as detailed, and according to manufacturer's installation instructions.

B. Install all items shipped loose by equipment manufacturer under supervision of equipment manufacturer's field service personnel.

C. Provide all field electrical wiring required in this Section of the specification. Install wiring in metal conduit and in accordance with Division 26 of this Specification and applicable Electrical Codes.

3.2 BOILER-BURNER UNITS

A. Manufacturer shall verify in writing that boilers have been cleaned according to their recommendations and are ready for operation.

B. Isolate boilers from piping system during boil-out.

C. Pipe vents from gas train to atmosphere. Size of each vent shall not be less than connection size to device.

D. Pipe boiler drains to nearest floor drains.

E. Install gas pressure gauges at downstream of gas pressure regulators.

F. If remote control panels are used, install all interconnecting wiring and pneumatic tubing if used between panels and units.

G. Provide remote shutdown switch outside of boiler room where shown and wire into boiler control/safety circuit to shut off fuel or energy supply when activated in accordance with ASME CSD-1.

END OF SECTION 235214

Boiler Shop Drawing Summary Sheet

General
- Project _____
- Identification _____
- Manufacturer _____
- Model Number _____
- Nominal Size (Boiler hp) _____
- Unit Length _____
- Unit Height _____
- Unit Width _____
- sq ft Surface Area _____
- Unit Type _____
- UL Listing _____
- ASME Stamp _____
- Normal Operating Pressure _____
- Boiler Input _____
- Boiler Output _____
- Factory Fire Test _____
- Number of Passes _____

Fuel Train and Burner
- Type _____
- FM Approved _____
- Turndown Ratio _____
- Gas Burner Type _____
- Efficiency (%) _____
- NO_x Emission in ppm _____
- Burner Manufacturer _____

Controls
- Microprocessor Based _____
- Outputs _____
- Cabinet Enclosure _____

Electrical
- Forced Draft Fan hp _____
- Control System Power _____
- Starters Included _____
- Cabinet Enclosure _____

Miscellaneous
- Press. Gauge/Stack Thermometer _____
- Low Water Cut-Out _____
- Auxiliary Low Water Cut-Out _____
- Water Column _____
- Gauge Glass Assembly _____
- Operating Pressure Control _____
- Feedwater Valve Control _____
- High Limit _____
- Relief Valves (size & quantity) _____
- Insulation _____

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SECTION 237214 - HEAT RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.2 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Capacities/ratings/efficiencies
3. Pressure/temperature rating
4. Materials of construction
5. Dimensions and weights
6. All other appropriate data

1.3 CHECK, TEST AND START

A. Heat recovery equipment installed within air handling unit shall be inspected and verified by heat recovery equipment manufacturer’s representative to ensure installation in accordance with manufacturer’s recommendation.

B. AHU manufacturer shall provide cost for commissioning field testing and certification of heat recovery equipment.

C. Rotary type heat exchanger manufacturer shall provide services of factory trained service engineer to supervise installation and start-up of heat exchangers, and to field measure purge air quantity, seal leakage and heat transfer efficiency. Service engineer shall also instruct Owner's representative in operation and maintenance of unit. Before acceptance by Owner, unit manufacturer's representative shall approve, and certify in writing, the complete installation including ductwork, wiring connections and proper functioning of all operational controls, and unit performance including heat transfer efficiency and air leakage quantities. Start-up shall not be performed until start-up date has been approved by Architect/Engineer.

1.4 WARRANTY

A. Standard 5 year material and labor warranty shall be provided covering all materials supplied and installed.

PART 2 - PRODUCTS

2.1 AIR-TO-AIR HEAT EXCHANGERS (FIXED PLATE TYPE)

A. Manufacturers: Venmar, Renewaire, dPoint, Allied Air Products Co. (Temp-X-Changer), Exothermics, ACS-Hoval, or Z Duct

B. Unit's capacity, efficiency and operating characteristics to be as scheduled.

C. Units to be capable of operating at temperatures from minimum of -60ºF up to maximum of 200ºF.

D. Entire unit must be capable of withstanding entrained moisture from outside air and also must withstand washdown of cleaning without harm to operation.

E. Unit Construction:

1. Construct casings from minimum #22 ga galvanized or aluminized steel, of design proven to mount and support unit in ductwork or in a piece of apparatus. Furnish all casings with minimum of 1-1/2" wide flange on each of 4 sides, both front and back for mounting.
2. Heat exchange surfaces shall be 0.021" thick diamond ribbed corrugated aluminum plates bonded to casing with isopthalic polyester resin. Seal plate edges with high temperature silicone sealant. Plate ends shall be clamped together with fiberglass seals and aluminum strips. Plate configuration shall be such that heated and cooled airstreams cross but do not mix. Units shall have no moving parts.
3. Furnish units with drain provision.

F. Controls:

1. Furnish unit with by-pass controls complete with by-pass duct, face and by-pass dampers, damper motors, thermostat and service switch.

G. Special Requirements:

1. Furnish unit with factory standard corrosion protection coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings, and in accordance with manufacturer's installation instruction.

B. Install access doors in ductwork or plenum at each side of unit in both supply and exhaust for inspection and cleaning.

C. Install Dwyer Series 2000 magnehelic pressure gauge across unit in supply air stream.

D. Install thermometer at each side of unit in both supply and exhaust.

3.2 AIR-TO-AIR HEAT EXCHANGERS (FIXED PLATE TYPE)

A. Provide insulation for unit as specified for outside air duct.

B. Install condensate drain pan and pipe to nearest floor drain.

C. Provide filter rack with 2” thick throwaway filter at entering side of unit for supply and exhaust air.

END OF SECTION 237214

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SECTION 237313 AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

B. Section 20 0514 - Variable Frequency Drive (VFD) System

C. Section 20 0529 - Piping and Equipment Supporting Devices

D. Section 20 0553 - Mechanical Systems Identification (Nameplate Markings)

E. Section 20 0700 - Mechanical Systems Insulation

F. Section 23 0550 - Vibration Isolation

G. Section 23 2116 - Pipe and Pipe Fittings

H. Section 23 2120 - Piping Specialties

I. Section 23 3314 - Ductwork Specialties

J. Section 23 3400 - Fans

K. Section 23 4114 - Filters

L. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

M. Section 26 0533 - Raceway and Boxes for Electrical Systems

N. Section 26 2726 - Wiring Devices

O. Section 26 2816 - Enclosed Switches and Circuit Breakers

P. Section 26 2913 - Enclosed Controllers

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplemental Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings (Product Data) for all equipment including, but not limited to, the following:

1. Appropriate identification.

2. Complete drawings showing plans and sections including details of construction.
3. Overall unit dimensions and individual components and sections dimensions.
4. Shipping and operating weight of unit and/or sections.
5. Structural design load.
6. Details of component support.
7. Capacities/ratings.
8. Materials of construction.
9. Thermal and acoustical performance of wall, roof and floor panels.
10. Pressure ratings and leakage ratings.
11. Thermal break construction details and performance calculations or test data.
12. Each component manufacturer's name, model number and data. (Refer to each component section for submittal requirements.)
13. Air leakage rates and test data.
14. Wiring diagrams and terminal points for control panels provided with units.
15. Manufacturer’s installation instructions.
16. Air handling unit manufacturer’s local representative and phone number.
17. Coil flow rate and pressure drop
18. Fan curves
19. Fan sound power levels
20. Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
21. Fan wheel type, diameter, rpm, tip speed
22. Required fan horsepower including drive losses
23. Fan motor data (refer to Section 20 0513 - Motors).

1.4 DESIGN CRITERIA

A. Furnish factory fabricated air handling units complete with fans, motors, variable pitch drives, coils, drain pans, filter sections, and damper sections, meeting configuration and as shown on drawings and/or as scheduled.

B. Units shall be tested, rated, and certified in accordance with AHRI Standard 430 and UL or ETL listed. All material shall meet NFPA 90A Flame Spread and Smoke Generation requirements.

C. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at the scheduled static pressure.

D. Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

E. Air handling unit static pressure shall take into consideration actual static pressure loss of components furnished within unit.

F. Motor furnished with fan shall not operate into motor service factor in any of these cases. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.

G. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor; drive and/or wiring changes required as result of duct configuration changes at fan.

1.5 INSPECTION AND CERTIFICATION

A. Unit manufacturer's representative shall inspect and verify that installation is conforming to manufacturer's recommendations.

B. Submit report to Engineer in writing certifying that installation is in accordance with manufacturer's recommendations.

1.6 FIELD LEAKAGE TEST

A. After completion of unit's installation, unit manufacturer and installing contractor shall jointly perform field casing leakage test.

B. Leakage test shall verify that unit casing leakage is less than **3%** of design air flow at **6" WG** pressure.

C. Submit certified test data to Engineer for approval.

1.7 FINAL CLEANING

A. Outside and inside of each air handling unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mill finish or grease. All proposed cleaning materials shall have contents identified and approved prior to use. Cover unit openings with sheetmetal or other proper material until ductwork is connected to maintain unit cleanliness.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Daikin (formally McQuay), Temtrol, Trane Climate Changer, York Solutions, or approved equal with operating characteristics as scheduled and physical dimensions as shown on drawings and/or detailed.

2.2 UNIT BASE

A. Unit base shall be fabricated from structural steel.

B. Base shall be sized to provide sufficient height above floor to accommodate cooling coil drain trap height indicated on details. Additional steel base may be used as sub-base to provide the required trap height. Sub-base may be provided at factory by unit manufacturer or provided at field by Installing Contractor.

C. Weld steel solid at connection points to assure rigidity. Size perimeter steel to allow for rigging and handling.

D. Locate and size base cross supports to support internal components.

E. Provide lifting lugs to perimeter base steel. Incorporate means of attaching cable or chain into each lug.

F. Base shall be split in maximum size pieces to allow for economical shipment to jobsite and placement within building. Provide bolting structural steel on both sides of split for field joining.

G. Unit base shall be primed and finished with rust inhibiting epoxy paint.

2.3 UNIT FLOOR

A. Unit floor shall be constructed to meet the maximum allowable deflection, and constructed of no lighter than:

1. 3/16” plate of aluminum with diamond-tread.
2. Floor plate shall be all welded 3/16” aluminum with diamond-tread.

B. Locate drain connection at lowest point of each floor section. Connections shall extend through perimeter base channel and be welded water tight. Provide removable, threaded cap on each drain connection. Drain pan connections shall allow connection to a 3/4” hose for drainage.

C. Provide minimum 1” high upturn lip on all floor sections.

D. Weld or drive screw flooring material to structural members below. For drive screw attachment assemblies, provide thermal gasket between screwed sections and sections shall not violate the upturn lip.

E. Entire floor including base drain pans shall be insulated on underside to have same thermal and acoustical performance specified for unit housing. Insulation shall be supported by minimum 20 ga galvanized steel liner with joints sealed to provide continuous vapor barrier.

1. Refer to Cooling Coil Section for cooling coil drain pan requirements.

2.4 UNIT HOUSING

A. Unit housing shall be constructed of 2” thick double wall panels meeting thermal, acoustical and structural requirements specified.

B. Panels shall utilize modular panel type construction. Panels may be self-supporting with internal support structure or supported by structural frame work.

C. Panel joints and seams shall be sealed with proper gasket and caulking to meet maximum allowable housing leakage rate specified.

D. Panel system, including service corridor where used, shall incorporate thermal break design at panel frames, joining mullions, supporting base, or corners. Thermal break is defined as prevention of condensation on outside surface of unit casing with **82** ºF) dry bulb and **82** ºFwet bulb temperature in adjacent space and 50°F dry bulb temperature inside air handling unit.

E. Unit manufacturer shall submit, as part of Shop Drawings, details of thermal break construction and calculations or test data indicating that thermal break design will prevent condensation on outside surface of unit casing with specified air temperatures at outside of unit and specified air temperature at inside of unit.

F. Outer face of panels for indoor units shall be constructed of no lighter than:

1. 18 ga galvanized steel

G. Solid inner face of panels shall be constructed of no lighter than:

1. 20 ga galvanized steel
2. 0.050” mill-finish aluminum
3. 18 ga Type 304 stainless steel. All interior panel joints shall be welded air-tight and suitable for washdown.
4. Unit casing shall be insulated with minimum [3 pcf density glass fiber] [3 pcf density glass fiber, or 3 pcf density polyurethane foam] insulation. Composite panel shall have heat transfer factor not greater than [0.06 Btu/(h·ft^2·°F)] [0.12 Btu/(h·ft^2·°F)]. All products as applied shall meet NFPA 90A possessing flame spread rating of not over 25 and smoke developed rating of not over 50.

H. Use solid inner surface for all sections except as noted herein.

I. Insulation:

1. Unit casing shall be insulated with minimum 3 pcf density glass fiber or 3 pcf density urethane foam insulation.
2. Composite panel shall have heat transfer factor not greater than 0.075 Btu/hr/sq ft/°F.
3. All products as applied shall meet ASTM E84 and NFPA 90A possessing flame spread rating of not over 25 and smoke developed rating of not over 50.

J. Blank-Off Panels:

1. Provide blank-off panels with proper gaskets and sealants to prevent air bypass around equipment such as filters, coils, humidifiers and sound attenuators.
2. Blank-off panels shall be constructed of galvanized steel no lighter than 16 ga unless otherwise noted.
3. Blank-off panels at cooling coil sections shall be 2” thick double wall construction with same insulation as housing panels.
4. Do not insulate blank-off panels between cooling coils located above drain pans.

K. Manufacturer shall have published literature available describing load-carrying capabilities and thermal characteristics of the panel system.

L. Panel Windows:

1. Provide window in panel wall where shown on plans.
2. Window shall be 1/4" thick tempered glass, double paned with vapor seal construction, minimum size of 12" x 12".

2.5 ACCESS DOORS

A. Each unit section shall have 24” x 72” access door, unless shown differently on drawings.

B. Fan section access door shall be sized to allow removal of fan wheel and motor through door, but not smaller than 30” x 72”. If access door needs to be wider than 36”, removable access panel may be provided.

C. Access doors and door frames shall have similar thermal break construction as specified under Unit Housing.

D. Access doors shall be same construction as housing panels.

E. Access doors located downstream of cooling coils shall be true thermal break design with no metal to metal contact.

F. Access doors shall be guaranteed tight closing through use of seals around entire periphery. Provide neoprene gasket between door frame and housing for air tight seal.

G. Each access door shall contain 1/4”thick wire glass or double glazed tempered glass window minimum size of 12" x 12". Window shall be double paned with vapor seal construction.

H. Each access door shall be furnished with corrosion resistant metal hinges or continuous piano hinge and shall have at least 2 stainless steel or aluminum alloy handles operable from both sides.

I. Doors shall open against higher air pressure to affect seal.

2.6 ACCESS SECTIONS

A. Construction shall be similar to unit casing with hinged door and flush mounted. Access door shall be sufficient size for service, but not to be less than 16” wide.

B. Provide access section as shown and between components.

2.7 FILTER SECTIONS

A. Filters shall be provided as specified and scheduled and shall meet requirements of appropriate Specification Sections.

B. Holding frames shall be installed by unit manufacturer to raise filters off floor and to prevent leakage as specified by unit manufacturer.

C. Provide filter holding frames for standard filter sizes of 16”x20”, 20”x20”, 20”x25” or 16”x25”.

D. Factory fabricated filter sections shall be of the same construction and finish as the unit.

E. Filter holding frames shall be minimum 16 gauge aluminum construction with filter sealing flange, similar to Camfil Farr Type 8 filter frames, assembled in a bank suitable for filters shown on schedule and drawings. Filter frames shall have dimples for centering filters in frame, holes for air filter spring clip fasteners, and a sealing flange with a foam gasket. Provide blank-off panel around filter frame assembly as required to prevent air bypass around filters.

F. Provide filter gauges (similar to Dwyer Series 2000) for each filter bank, suitable for flush mounting in a panel, including air filter gauge accessory package for use with 1/4" OD copper tubing. Provide gauge with green and red transparent overlays to emphasize critical pressures. Green overlay shall be from 0” H2O to final pressure drop as indicated in the filter schedule for each filter. Red overlay shall be from final pressure drop to gauge maximum pressure. Select scale range for gauge based on filter efficiencies shown below.

Filter Type	Scale Range (inch WG)
Filters with 25 to 30% efficiency based on atmospheric dust spot test	0 - 1.0
Filters with 31 to 99% efficiency based on atmospheric dust spot	0 - 2.0

2.8 PREHEAT COIL SECTION

A. Provide preheat coils, piping and internal piping as specified and indicated on drawings.

B. Install coils, piping, and specialties not to block face area of coils. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.

C. Each coil shall be supported by galvanized steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access doors. Blank-off panels shall be galvanized steel sheets.

2.9 COOLING COIL SECTIONS

A. Cooling coils, piping and piping specialties shall be provided as specified, and indicated on drawings, and shall meet requirements of appropriate Specification Sections.

B. Install coils, internal piping, and specialties not to block face area of coils. Terminate piping outside of unit casing for connection by Mechanical Contractor. Provide necessary pipe supports and hangers.

C. Casings shall be minimum 16 ga stainless steel having stainless steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

D. Coils shall be constructed of 0.035" tube wall, 5/8" OD seamless copper tubes with 0.010” thick aluminum fins suitable, for working pressures to 200 psig.

E. Coils shall be tested at 250 psig under water.

F. Coil fins shall be continuous plate fin type.

G. Coil headers shall be constructed of cast iron with tubes expanded into headers, steel pipe with brazed tube connections, or heavy seamless copper with tubes brazed to header.

H. Select coils for tube velocity not less than 3.0 fps.

I. Unless otherwise noted on air handling unit schedule, maximum allowable fin spacing shall be 10 fins per inch. Unless otherwise noted on air handling unit schedule, coil depth shall not exceed 10 rows.

J. Each coil shall be supported by 304 stainless steel frame which is independent of unit casing. Support frame shall allow individual coil removal. Coils shall be removable through unit access

doors or removable access panels. Blank-off panels shall be 304 stainless steel sheet with insulation as specified.

K. Each coil support shall include minimum 16 ga 304 stainless steel, all welded, double wall, insulated, condensate drain pan extending 3 feet downstream of coil face. Each drain pan shall have sufficient depth to hold condensate water but not less than 2". Drain pan shall be sloped in 2 directions (pitched down in direction of airflow and pitched sideways to drain connection) for self-drainage at minimum 1/4" per foot slope. Drain pan shall be individually piped down to drain pan located below, and bottom drain pan to be piped to hub drain at exterior of unit. Drain connection opening shall be flush with bottom of pan. Side pan connection located at lowest point of pan may be used only where bottom pan connection cannot be used. Drain pipe shall be 304 stainless steel with sufficient size, but not less than 1-1/2".

L. Drain pipe connections shall not be located directly under access doors.

M. Upper drain pans shall extend from upstream of coil face continuously to 18" downstream of cooling coil face. Bottom drain pan shall extend from upstream of coil face continuously to 36" downstream of cooling coil face.

N. Instead of drain pan under bottom coil, recessed pan, integral with unit floor may be used. It shall be constructed as specified above including thermal insulation and drain lines, and shall incorporate required drain trap height.

2.10 FAN SECTION

A. Fan(s) and motor(s) shall be provided as scheduled and shall meet requirements of appropriate Specification Sections.

B. The multiple fan array shall consist of multiple fan and motor cartridges arranged in rows and columns, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. The multiple fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the multiple fan array intake plenum wall, and at a distance of 48" from the discharge side of the multiple fan array intake plenum wall.

C. Each fan/motor cartridge shall consist of a direct drive, arrangement 4 plenum fan constructed per AMCA requirements for class I, II, or III duty as required. All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified fan/motor speed. The multiple fan array shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed.

D. Each fan and motor assembly shall be factory mounted on vibration isolation equipment meeting requirements of Section 23 0550 - Vibration Isolation, unless shown otherwise. Vibration base shall include integral adjustable motor base as appropriate.

E. Provide track in fan section suitable for use with trolley-type winch, to be used for removing fan motor. The inside end of the track shall be centered over the motor side of the multiple fan array, and the outer end of the track shall be centered with fan section access door.

F. The entire plenum fan and drive assembly shall be encased with protective screen enclosure. Enclosure shall be constructed of aluminum or galvanized steel mesh or expanded metal and

sized to have no measurable system effect on fan performance. Screen shall be reinforced as required to maintain stable structure during fan operation. Access shall be provided for periodic service. Door shall be of suitable size to allow service access into enclosure. Enclosure shall be designed and constructed to allow for complete disassembly.

G. Each fan shall be provided with a heavy gauge, corrosion resistant, zinc plated steel wire inlet screen.

H. Each fan shall be provided with a precision spun inlet cone. Inlet cones shall be aerodynamically matched to wheel side plate to insure full loading of blades. Inlet cones shall be heavy gauge steel.

I. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

J. Each fan/motor assembly shall be removable through a 30” wide (based on free area), access door located on the discharge side of the fan array.

K. The fan intake wall, inlet funnel, and motor support structure shall be provided with a corrosion resistance coating equal to with air dried industrial grade alkyd enamel.

L. Electrical Components and Wiring: Each supply fan section consisting of multiple fans and motors shall be factory pre-wired with the components listed herein; and each section shall be designed to accept a single-point power connection for incoming line voltage power wiring from a single, remote variable frequency drive (VFD) serving that section.

1. Provide a NEMA 1 gasketed enclosure in a readily accessible location on the exterior of the unit. The enclosure shall contain:
   a. Power distribution block(s) configured to accept a single-point power connection from a remote VFD serving that section.
   b. Wiring and additional power distribution block(s), as required, to break out the single feeder incoming power wiring into multiple branch feeders to the multiple fan motors of that section.
   c. Equipment grounding bus or lug.
   d. Separate motor branch circuit disconnect for each fan motor. Disconnects shall have permanent provisions for padlocking in the OFF position.
   e. Provide engraved, laminated plastic nameplate on cover of enclosure to identify motors served. Attach using screws or rivets; do not use adhesive.

2. Each branch feeder to an individual fan motor shall be designed and equipped to comply with the requirements of Article 430 of the National Electrical Code including:
   a. Motor circuit conductors – Article 430.21.
   b. Motor and branch-circuit overload protection – Article 430.32. Provide a separate overload device for each motor as required.
   c. Motor branch-circuit short-circuit and ground fault protection – Article 430.51.
   d. Motor overtemperature protection – Article 430.126. Provide separate overtemperature protection for each motor as required.

3. Overload and overtemperature devices may be contained in the NEMA 1 enclosure described above or elsewhere in the section as determined by the manufacturer.
4. Label all wiring and power distribution block positions according to factory wiring diagram furnished with unit.

M. All motor wiring for the unit fan section shall be completely pre-wired within unit at factory. The only field wiring connection required shall be the incoming line voltage power wiring from a remote VFD to a single-point connection in the NEMA 1 enclosure.

2.11 DISCHARGE AIR SECTION

A. Provide with framed discharge opening or spun bellmouth fitting conforming to size and configuration of the ductwork.

2.12 CONTROL DAMPERS

A. Refer to Section 23 0902 - Control Valves and Dampers, for control dampers.

B. Outside air dampers shall be insulated blade dampers equal to Tamco Series 9000.

1. Extruded aluminum (6063T5) damper frame shall not be less than 0.080” in thickness. Damper frame shall be 4” deep. Outside air dampers shall be insulated with polystyrofoam on four sides.
2. Blades shall be extruded aluminum (6063T5) profiles. Dampers shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and temperature index of 55.
3. Blade seals shall be of extruded EPDM. Frame seals shall be of extruded TPE thermoplastic. Seals shall be secured in integral slot within aluminum extrusions.
4. Bearings shall be composed of Celcon inner bearing fixed to 7/16” aluminum hexagon blade pin, rotating within polycarbonate outer bearing inserted in frame, resulting in no metal-to-metal or metal-to-plastic contact.
5. Linkage hardware shall be installed in frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for slip-proof grip.
6. Dampers shall be designed for operation in temperatures ranging between -40°F and 212°F.
7. Air leakage through 48” x 48” damper shall not exceed 4.12 cfm/ft^2 against 4" WG differential static pressure at standard air.
8. Pressure drop of fully open 48” x 48” damper shall not exceed .03" WG at 1000 fpm.

2.13 CONTROLS

A. Control devices will be provided by Control Contractor. Unit manufacturer shall coordinate with Control Contractor and provide sleeved openings on unit housing for control devices.

2.14 TESTING

A. Submit certified test data for both factory test and field test to Engineer for approval.

B. Unit manufacturer shall provide factory tests to verify casing leakage after units are assembled.

C. Unit manufacturer and installing contractor shall jointly provide field tests to verify casing leakage after units are installed at jobsite. Coordinate with Electrical Contractor for power to unit test fan.

D. Casing leakage tests shall verify that unit casing leakage is less than 1% of design air flow at +/- 8 inches WG static pressure.

1. Seal duct openings in positive pressure section. Connect this section to fan developing 8 inches WG positive static pressure, and read air flow of this fan using approved air flow measuring device. Fan air flow measurement shall be considered casing leakage of this Section.
2. Seal duct openings in suction side of unit. Connect this section to fan developing -8 inches WG negative static pressure, and read fan air flow of this fan using approved air flow measuring device. Fan air flow shall be considered casing leakage of this Section.
3. Conduct casing leakage test individually for each air handling unit. Total casing leakage shall be calculated as sum of positive pressure section leakage and negative pressure sections leakage. Total casing leakage shall not exceed the allowable rate specified above.

E. Unit manufacturer shall provide factory or field panel deflection test.

1. Panel deflection test for panels under positive pressure shall verify that unit casing deflection is less than 1/200 of the longest plane being measured at 1-1/2 times design static pressure or 8" WG positive, whichever is greater.
2. Panel deflection test for panels under negative pressure shall verify that unit casing deflection is less than 1/200 of the longest plane being measured at 1-1/2 times design static pressure or 8" WG negative, whichever is more negative.
3. Deflection shall be measured at 2 points for positive pressure sections and 2 points for negative pressure sections (total 4 points at panel seams) at mid-point of panel height.

2.15 ELECTRICAL SERVICE

A. Provide adequate lighting and switching so equipment can be observed and maintained in safe manner. Combination lighting and convenience outlet circuit is required for each section of unit. Each access section shall contain a minimum of one light fixture. Sections wider than 12 ft shall have multiple light fixtures with maximum spacing of 6 ft.

1. Provide light switch with pilot light for each access section. Locate switch near access door.
2. Wire all lights to single junction box with single switch with pilot light.
3. Provide timer for light switch to automatically turn off lights after preset time. Timer shall be similar to Intermatic Model FF2H with 0-2 h range and hold feature to override automatic shut-off function.
4. Light fixtures shall be: fluorescent tube type. Provide bulbs for each fixture.

B. Lights, switches, convenience outlets, wiring and conduit shall meet requirements of appropriate Specification Sections of Division 26.

C. Wiring inside of unit shall be provided by unit manufacturer meeting requirements of NEC and appropriate Specification Sections of Division 26. In addition, wiring shall be in metallic conduits.

1. Provide junction box for each fan motor at outside of unit wall for 3 Ph, 480 V power connection and separate junction box for 1 Ph, 120 V power connection.

2. Provide two points of power connection, one for 3 Ph, 480 V and one for 1 Ph, 120 V power connection.

D. Seal electrical penetrations into unit air-tight.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Units shall be assembled in unit manufacturer's plant to allow for testing of complete unit.

B. Unit manufacturer shall supervise and be responsible for all field joining of the modules, including sheet metal, electrical and piping. Local trades may provide labor for unit assembly and installation.

C. Joints in floor between modules shall be air and water tight.

D. Unit manufacturer shall provide and install all equipment within unit as specified including fans, motors, coils, dampers, piping, ductwork specialties, lights, switches and all equipment necessary to complete air handling equipment contained within housings. Mechanical and electrical connections (i.e., piping and conduit) shall be stubbed through housing so that appropriate Contractor may provide service to air handling unit. Electrical wiring and control wiring shall terminate in junction boxes on accessible side of unit.

E. Provide structural steel sub-base as required. Refer to Unit Base in Part 2.

F. Field mounting of any equipment on housing walls or roof is not allowed without prior approval of Engineer.

G. Unit manufacturer and installing contractor shall coordinate with other trade Contractors, all necessary requirements to assure proper air handling unit installation.

3.2 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling unit components for static pressure differential or temperature measurements. Refer to Section 23 3314 - Ductwork Specialties, for instrument test holes.

3.3 PROTECTION OF OPENINGS

A. Protect openings on housings during construction against entry of foreign matter and construction dirt.

3.4 FIELD TESTING

A. Unit manufacturer and installing contractor shall jointly perform field casing leakage test on each completed housing assembly as previously specified and shall be responsible for repair of all leaks. Submit certified test data to Engineer for approval.

B. Temporary sealing of access doors, condensate drains, etc. is not allowed during field testing except to troubleshoot leakage points.

END OF SECTION 237328

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SECTION 238214 - HEATING AND COOLING TERMINAL DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

1.2 REFERENCE

A. **Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.**

1.3 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Dimensions and weights
6. Color selection chart where applicable
7. Wiring diagrams
8. Motor data (refer to Section 20 0513 - Motors)
9. For chilled beams, submit performance data from independent testing agency. Performance data to include cooling capacity at supply water temperatures scheduled, air pressure drop, sound data, and water pressure drop for each beam length.
10. All other appropriate data

B. LEED Submittal:

1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1-2007, Section 5 – “Systems and Equipment.”

1.4 REFERENCE STANDARDS AND DESIGN CRITERIA

A. Duct Reheat Coils: Ratings shall be certified in accordance with AHRI Standard 410.

B. Finned-Tube Radiation: Ratings shall be IBR Certified.

C. Convectors: Ratings shall be in accordance with Commercial Standard CS 140.

D. Units including electrical work shall be UL Listed.

E. Electric Heaters: Shall be listed by UL, bear appropriate UL Label, contain the latest devices for protection of installation, and shall be installed in strict accordance with the latest revision of National Electric Code and other applicable State and Local Codes. Provide grounding lugs on all apparatus.

PART 2 - PRODUCTS

2.1 DUCT REHEAT COILS (HOT WATER)

A. Manufacturers: Carrier, Trane, McQuay, RAE, Marlo, Temtrol, or Heatcraft

B. Reheat coils furnished with air terminal devices will be acceptable, provided coils are meeting requirements specified in this section.

C. Coils shall be constructed of 0.016” minimum tube wall, 1/2" or 5/8" OD copper tubes with aluminum fins suitable for minimum working pressure to 200 psig and temperatures to 220°F.

D. Coils having steel nipples for connection are not allowed.

E. Coil fins shall be continuous serpentine or plate fin type.

F. Coil headers shall be heavy seamless copper with all tubes brazed to header.

G. Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

H. Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.2 FAN COIL UNITS

A. Manufacturers: Enviro-Tec, York, JCI, Carrier, Trane, McQuay, Rittling, International Environmental Corporation (IEC), VTS, Greenheck, or Modine

B. Unit data shall be certified in accordance with AHRI Standard 430 or 440.

C. Coils shall be constructed of 3/8", 1/2" or 5/8" OD seamless copper tubes with aluminum fins suitable for maximum working pressure to 300 psig and temperatures to 200ºF. Coil stub outs shall be 5/8" OD copper tubing. Furnish coils with manual air vents. Coil performance data shall be in accordance with AHRI Standard 410.

D. Units shall be furnished with centrifugal fans, separate hot and chilled water coils as scheduled, speed selection switches, condensate drain pans, and galvanized steel casings.

E. Drain Pans

1. Primary condensate drain pans shall be single wall; heavy gauge galvanized steel for corrosion resistance and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal.
2. Drain pans shall be field reversible for right or left hand connections.

3. Drain pan shall be externally insulated with fire retardant, closed cell foam insulation. Insulation shall carry no more than 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.
4. Furnish drain pan with secondary drain connection located at higher level than primary drain connection for condensate overflow.
5. Pipe secondary drain separately from primary drain with p-trap to the nearest hub drain.
6. Furnish drain pan with condensate overflow switch conforming to UL 508 for condensate overflow unit fan shut off. Locate switch just below secondary drain connection. Pipe secondary drain to primary drain line before p-trap.

F. Units shall be furnished with 18 ga steel cabinet and access to all internal mechanical and electrical devices. Cabinets of exposed units shall have baked enamel finish in one of manufacturer's standard colors, selected by Architect. Cabinets of concealed units may be prime coated or galvanized steel. Ducted units shall be furnished with supply and return duct collars.

G. Fan wheels shall be aluminum or galvanized steel construction, centrifugal forward-curved and double-width type, statically and dynamically balanced.

H. Unless otherwise indicated, furnish units with 3-speed permanent split capacitor motors with thermal overload protection with automatic reset.

I. Furnish units with brushless DC electrically commutated motor (ECM) with permanent magnetic rotor and built-in microprocessor based variable controller. Provide electronic speed control with field adjustment.

J. Units shall be acoustically and thermally insulated with minimum 1/2" glass fiber insulation. Drain pans shall be constructed of galvanized steel or stainless steel insulated with minimum 1/4" fire retardant closed cell foam. Drain pan shall be constructed in compliance with ASHRAE 62.1-2010 and insulation shall meet requirements of NFPA 90A.

K. Each unit shall include readily accessible filter rack. Furnish 2 sets of 2" thick minimum efficiency MERV-8, based on ASHRAE Test Standard 52.2, throwaway glass fiber filter for each unit.

L. Furnish each unit with factory mounted non-fused disconnect switch, short circuit protection of all internal components, motor starter, and over current protection.

2.3 ACTIVE CHILLED BEAMS

A. Manufacturers: JCI, Swegon, Titus, Flakt Wood, Dadanco, Semco, Price, or approved equal.

B. Units shall be active chilled beam design with primary air connections, induction nozzles, chilled water coils, integral air diffusers and removable perforated induction inlet grille. Units shall be designed for 2-pipe, cooling only duty.

C. All components of chilled beam shall meet NFPA 90A requirements for flame spread and smoke developed.

D. Units shall have removable and interchangeable plastic induction nozzles.

E. Inlet/discharge grille framework shall be constructed of aluminum or pressed steel components. Inlet grille shall be perforated steel or aluminum, of sufficient gauge to avoid sagging. Air plenum

shall be constructed of minimum 22 ga steel. Interior of plenum shall be painted black if visible from room side.

F. Diffuser and induction grille face shall be powder coat or baked enamel finish of manufacturer's standard white color.

G. Units shall be designed with standard US (IP) dimensions and NPT pipe connections.

H. Units shall be nominal 24" or 12" wide as scheduled and shall be compatible with standard or narrow type t-bar ceiling grid as indicated on plans.

I. Unit face shall be drop-face or flat-face as scheduled.

J. Housing shall be formed/stamped aluminum or galvanized steel with manufacturer's standard baked white enamel finish.

K. Housing shall be complete with flush mounted, removable perforated induction grille in center portion for access to cooling coil, supply air plenum with inlet duct collars as required (5" minimum diameter), induction nozzles, and slotted supply diffusers in 1-way or 2-way configuration as scheduled.

L. Induction inlet grille on one-way or two-way throw units shall be removable for coil access. Grilles shall have safety cables or chains to support grille core during coil access and shall be hinged along one side of grille to allow grille core to swing down 90° for coil access.

M. Provide adjustable support tabs/brackets, minimum 4 per unit for hanger support from structure.

N. Water coils shall be constructed of 1/2" or 5/8" OD seamless copper tubes with minimum wall thickness of 0.016" with aluminum fins suitable for minimum working pressure to 300 psig at 75ºF temperature. Coil connections shall be NPT threaded.

O. Where required, provide dual coils with factory pre-piped single point supply and return connections for additional capacity.

P. Provide flexible metal hose pipe connectors with stainless steel braided outer jacket for each chilled beam. Minimum live length of metal flexible hose shall be 18". Flexible connectors shall be rated for minimum working pressure of 150 psig at 70ºF and each connector shall be factory leak tested prior to shipment.

Q. Submittals shall include performance data from independent testing agency. Performance data to include cooling/heating capacity at supply water temperatures scheduled, air pressure drop, supply air throw performance, sound data and water pressure drop for each chilled beam length and throw configuration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as indicated on drawings, and according to manufacturer's installation instructions.

B. Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

C. Protect units during construction against entry of foreign matter and construction dirt.

D. Unless otherwise shown on drawings, mount vertical type wall mounted heating units 12" above finished floor.

3.2 DUCT REHEAT COILS

A. Comb out fins when bent or crushed before enclosing coils in ductwork. Clean dust and debris from each coil to ensure its cleanliness.

B. Seal or gasket coil connection to ductwork to meet maximum allowable leakage rate specified in Section 23 3114 - Ductwork, Part 3.

C. Protect units during construction against entry of foreign matter and construction dirt.

D. Unless otherwise specified, connect piping to coils with multiple rows for counter-flow arrangement.

3.3 FAN COIL UNITS

A. Mount units above concealed ceilings or as shown on drawings with ample clearances for coil pull and filter service.

B. Provide vibration isolation hangers for support of each unit.

C. Duct connections to fan coil units shall use flexible duct connections.

3.4 ACTIVE CHILLED BEAMS

A. Mount units in ceilings as shown on drawings and on reflected ceiling plans.

B. Support units independently of ceiling grid and directly from building structure, with minimum of 4 supports per chilled beam, using threaded rod or approved cable supported system. Wire supports are not allowed.

C. Where necessary, provide strut supports spanning under wide obstructions (ducts) to allow for proper alignment of chilled beam to ceiling grid.

D. Install manual air vents for complete venting of air from system. Provide drain valves at low points of main or branch main piping.

E. Multiple chilled beams may be zoned to match associated supply air terminals and controlled through single control valve. Refer to chilled beam schedule and/or drawings for chilled beams served by common control valve.

END OF SECTION 238214

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SECTION 260000 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.

G. Where architectural features govern location of work, refer to Architectural Drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.2 RELATED WORK

A. Utility Services:

1. Determine utility connection requirements and include in Base Bid all costs to Owner for utility service.
2. Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.

B. Temporary Services:

1. Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:

1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
2. When interruption of services is required, Architect, Owner and other concerned parties shall be notified and shall determine a time.

D. Demolition:

1. Division 02 - Selective Demolition
2. Division 02 - Building Demolition
3. Perform required demolition to accomplish new work.
   a. Remove abandoned wiring to source of supply.
   b. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
   c. Disconnect abandoned outlets and remove devices.
   d. Remove abandoned outlets if conduit servicing them is abandoned and removed.
   e. Provide blank cover for abandoned outlets that are not removed.
   f. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
   g. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
   h. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

4. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other Contractors.
5. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
6. Equipment noted to be removed and turned over to Owner, shall be delivered to Owner at place and time Owner designates.
7. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
8. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other Contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.

E. Cleaning and Repair

1. Clean and repair existing materials and equipment that remain or are to be reused.
2. Panelboards.
   a. Clean exposed surfaces and check tightness of electrical connections.
   b. Replace damaged circuit breakers and provide closure plates for vacant positions.
   c. Provide typed circuit directory showing revised circuiting arrangement.

3. Luminaires:
   a. Remove existing luminaries for cleaning.
   b. Use mild detergent to clean exterior and interior surfaces; rinse with clean water and wipe dry.
   c. Replace broken electrical parts.

F. Concrete Work:

1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.

2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.

G. Painting:

1. Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.
2. Furnish equipment with factory applied prime finish unless otherwise specified.
3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
4. Furnish one can of touch up paint for each final factory-applied finish coat of product.
5. Paints and coatings used on the interior of the building shall comply with VOC limits per Section 01352 LEED requirements.

H. Sustainable Architecture and LEED Requirements:

1. Provide services, documentation, and product data required to meet LEED credits involving electrical components.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.4 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1. AEIC Association of Edison Illuminating Companies
2. ANSI American National Standards Institute
3. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers
4. ASME American Society of Mechanical Engineers
5. ASTM American Society for Testing and Materials
6. BICSI Building Industry Consulting Services International
7. EIA Electronic Industries Association
8. FBC Florida Building Code
9. FFPC Florida Fire Prevention Code
10. FIPS Federal Information Processing Standards
11. FCC Federal Communications Commission
12. ICEA Insulated Cable Engineers Association
13. IEEE Institute of Electrical & Electronics Engineers
14. IESNA Illuminating Engineering Society of North America
15. NEC National Electrical Code
16. NECA National Electrical Contractors Association
17. NEMA National Electrical Manufacturers Association
18. NESC National Electrical Safety Code
19. NETA National Electrical Testing Association
20. NFPA National Fire Protection Association
21. NIST National Institute of Standards & Technology
22. OSHA Occupational Safety and Health Administration
23. TIA Telecommunications Industries Association
24. UL Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.5 LISTING

A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.

B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.6 ENCLOSURES

A. Typical NEMA Enclosures and Usage

1. NEMA 1 - Indoors. Falling dirt.
2. NEMA 3R - Outdoors. Rain, snow, sleet.
3. NEMA 4X. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Corrosion resistant.

1.7 SUBMITTALS

A. Shop Drawings (Product Data):

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
7. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
8. Include wiring diagrams for electrically powered or controlled equipment.
9. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
12. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 - Operation and Maintenance Data.
2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
4. Manuals shall include the following:
   a. Copies of shop drawings
   b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
   c. CD ROM's of O&M data with exploded parts lists where available
   d. Phone numbers and addresses of local parts suppliers and service companies
   e. Internet/WEB page addresses where applicable
   f. Wiring diagrams
   g. Start up and shut down procedure
   h. Factory and field test records
   i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section

5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. Furnish O&M manuals and instructions to Owner prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.8 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Coordination:

1. Equipment provided under other Divisions of these specifications.
   a. Motors
   b. Electrically powered equipment
   c. Electrically controlled equipment
   d. Starters, where specified
   e. Variable frequency drives, where specified
   f. Control devices, where specified
   g. Temperature Control wiring

2. Provide the following devices required for control of motors or electrical equipment, unless noted otherwise:

a. Starters
b. Disconnect devices
c. Control devices:
   1). Pushbuttons
   2). Pilot lights
   3). Contacts
d. Conduit, boxes and wiring for Power wiring
e. Conduit, boxes and wiring for Control wiring, except for control wiring systems as defined in Section 23 0901.

3. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
4. Wire starters or other similar control devices furnished by others.
5. This contractor's drawings and/or specifications show number and hp rating of motors furnished by others, together with their actuating devices. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.
6. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)
7. Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.

C. Cutting and Patching:

1. Refer to General Conditions of the Contract and Division 01 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:

1. Refer to Division 01 - Closeout Procedures.
2. As work progresses or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.9 WARRANTY

A. Refer to technical sections for warranty requirement for each system.

1. Where no warranty requirements are called out, warrant for 1 year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

B. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

C. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

D. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Provide supplemental heat if required to prevent moisture contamination.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 07 8413 - Penetration Firestopping.

G. Adhesives and sealants used on the interior of the building shall comply with VOC limits per section 01352 LEED requirements.

H. Provide 2” clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified.

M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.

E. Provide access doors in walls, chases or inaccessible ceilings for equipment requiring access for servicing, repairs and maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire-rated construction with UL label. Provide steel, prime-coated access doors in dry locations. Provide stainless steel access doors for use in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.

F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.7 ELECTRICAL SYSTEMS IDENTIFICATION

A. Refer to Section 26 0553 – Electrical Systems Identification.

3.8 START-UP

A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.9 CLEANING

A. Clean systems after installation is complete.

B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.

D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

F. During construction, maintain indoor air quality per general contractors IAQ plan for LEED credit.

3.10 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste management shall be managed in accordance with provisions of Section 01524 Construction Waste Management. Documentation shall be submitted to satisfy the requirements of that section.

END OF SECTION 260000

SECTION 260516 - OWNER-FURNISHED EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes electrical connection(s) to Owner-purchased pieces of equipment, which are required in construction.

B. Owner-furnished equipment requiring work by Contractor is specified in the following Sections:

C. Contractor shall be responsible for receipt of equipment from Owner, storage after receipt, installation, and electrical connection.

D. Owner-furnished equipment requiring work by the Contractor is shown on the drawings and schedules.

E. Owner-furnished, Contractor-installed equipment is labeled OFCI.

1.2 SUBMITTALS

A. Shop Drawings: Owner-supplied shop drawings of equipment furnished by Owner.

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.5 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide labor, materials and electrical connections for Owner-furnished equipment in accordance with contract drawings.

B. Install and connect Owner-furnished equipment as though it had been purchased by Contractor.

1. This shall include:
   a. Receiving equipment at jobsite
   b. Rigging and setting equipment in place
   c. Making electrical connections
   d. Starting
   e. Testing

C. Install equipment in accordance with manufacturer's installation instructions.

D. Maintain equipment until facility is accepted by Owner.

E. Review Owner-supplied shop drawings of Owner-furnished equipment to ascertain that necessary labor and materials have been provided to install equipment and complete the system it serves.

END OF SECTION 260516

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0529 - Hangers and Supports for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

1.2 DESCRIPTION

A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.

B. Conductor and conduit sizes in these contract documents are based on copper and aluminum wire.

1.3 REFERENCE STANDARDS

A. ASTM B 1 – Standard Specification for Hand-Drawn Copper Wire.

B. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. NFPA 70 – National Electrical Code.

D. UL 44 – Thermoset-Insulated Wires and Cables.

E. UL 83 – Thermoplastic-Insulated Wires and Cables.

F. UL 486A-486B – Wire Connectors.

G. UL 486C – Splicing Wire Connectors.

H. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

I. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations of components and circuits.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Wire and cable boxes and reels shall bear the date of manufacture.

1. Date of manufacture shall not precede contract date by more than one year.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Alcan Products Corporation; Alcan Cable Division

B. General Cable Corporation

C. Cerrowire

D. Southwire Company

E. Encore Wire Corporation

2.2 DESCRIPTION

A. NEMA WC 70; single copper insulated wire; single aluminum insulated wire where indicated on drawings; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations

1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THHW, THW-2, THWN-2.
2. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW, XHHW-2 and SO.

2.3 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1

1. Copper conductor, single insulated wire.
2. Insulation type THHN, THHW, XHHW rated 90°C, 600 V insulation class.
3. Type XHHW for ambient temperature less than 32°F.
4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3

1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
2. Insulation type XLEP, rated 105°C, 300 V insulation class.
3. UL listed for use in space in which circuits will be installed.

2.4 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division
5. Tyco Electronics Corp.

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.5 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.6 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

A. Install conductors in a raceway system, unless otherwise specified or indicated.

B. Install conductors only after:

1. Building interior is enclosed and weather tight
2. Mechanical work likely to damage conductors has been completed
3. Raceway installation is complete and supported

C. Pull conductors into raceway at same time.

D. Neatly train and lace conductors inside boxes, equipment, and panelboards.

E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Protect exposed cables from damage.

I. Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

J. Support cables and conductors in vertical raceways per requirements in Section 26 0529 - Hangers and Supports for Electrical Systems.

K. Identify and color-code conductors and cables according to Section 26 0553 - Electrical Systems Identification.

L. Wiring at Outlets: Install conductor at each outlet, with minimum 6" of slack.

M. Limit conduit fill to a maximum of 9 current-carrying conductors.

N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

O. Install VFD input wiring, output wiring and control wiring in their own separate conduit systems.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; Aluminum where indicated on drawings. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.

B. Branch Circuits: Copper. Solid or stranded for #10 AWG and smaller; stranded for #8 AWG and larger.

C. Minimum conductor sizes shall be as follows:

1. #12 AWG – Branch circuits of any kind.
2. #14 AWG – Fire alarm system.
3. #16 AWG – Remote control and signal systems.

D. Branch wiring length limitations:

1. 208Y/120 V circuits over 100’ in length: Increase wire size one size for each 100’ of length. Increase conduit size as required.
2. 480Y/277 V circuits over 150’ in length: Increase wire size one size for each 150’ of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, XHHW-2, rated 90°C for wet locations, single conductors in raceway.

B. Feeders: Type THHN/THWN-2, XHHW-2, rated 90°C for wet locations, single conductors in raceway.

C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN, THW-2, THWN-2, XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.

D. Motor Circuit Branch Wiring and Associated Control Wiring: Type THHN, rated 90°C for dry and damp locations, single conductors in raceway, stranded.

E. Motor Circuit Branch Wiring Between Motor and VFD: XHHW-2

F. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Sizing – #16 AWG minimum.

B. Installation:

1. Install cables in cable tray and j-hooks.
2. Provide protection for exposed cables where subject to damage.
3. Support cables above accessible ceilings; do not rest on ceiling tiles.
4. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES, AND TERMINALS

A. Connectors:

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
4. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.
5. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only.
6. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

B. Splices:

1. Splice wires and cable only in accessible locations such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
5. Plastic snap-on splice insulators are not allowed.
6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
7. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Terminals:

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
3. Train wires to eliminate fanning of stands, crimp with proper tool and die.

4. Torque screw termination per manufacturer's recommended values.

3.6 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 FIELD QUALITY CONTROL

A. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0543 - Ducts and Raceways for Electrical Systems

B. Section 26 4113 - Lightning Protection for Structures

C. Section 27 1000 - Structured Cabling

D. Section 27 1100 - Communications Equipment Room Fittings

E. Section 27 1300 - Communications Backbone Cabling

F. Section 27 1500 - Communications Horizontal Cabling

1.2 DESCRIPTION

A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein, plus the following special applications:

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

B. Maximum resistance to ground shall be less than 5 ohms.

C. Refer to Grounding Riser Diagram.

1.3 REFERENCE STANDARDS

A. TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

B. ASTM B 3 – Specification for Soft or Annealed Copper Wire

C. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft

D. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

E. IEEE C2 – National Electrical Safety Code (ANSI)

F. IEEE 857 – Standard for Qualifying Permanent Connections Used in Substation Grounding

G. NETA MTS – Maintenance Testing Specifications

H. NFPA 70 – National Electrical Code

I. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

J. NFPA 780 – Lightning Protection Systems

K. UL 96 – Lightning Protection Components

L. UL 467 – Grounding and Bonding Equipment

1.4 TELECOMMUNICATIONS GROUNDING SYSTEM DEFINITIONS

A. Telecommunications Grounding Busbar (TGB): Interface to building telecommunications grounding system, common point of connection for telecommunications system and equipment to ground, and located in telecommunications room or equipment room.

B. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Test wells
2. Ground rods
3. Grounding arrangements and connections for separately derived systems
4. Grounding for sensitive electronic equipment

C. Field Quality-Control Test Reports:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
2. Test reports of resistance to earth. Each test report shall include:
   a. Date of test, soil moisture content, and soil temperature
   b. Test operator
   c. Instrument or other test equipment used
   d. Electrode designation or location
   e. Ground impedance in ohms
   f. Assumptions made - if required

D. Closeout Submittals:

1. Operation and Maintenance Manuals: Include the following:

a. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NETA MTS.
   1) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
   2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
2. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable; Aluminum wire or cable where indicated on drawings; 600 V insulation unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4” in diameter.
5. Bonding Conductor: #4 AWG or #6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8” wide and 1/16” thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8” wide and 1/16” thick.

C. Grounding Bus: Horizontal rectangular bars of annealed copper, 1/4” thick; with insulators.

1. Main ground bus (MGB): 24” long x 4” wide
2. Ground bus (GB): 12” long x 2” wide

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Electro-tin plated copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Compression Connectors: Irreversible type.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4” in diameter by 10 ft in length.

2.4 TELECOMMUNICATIONS BUSBARS

A. Material: Copper

1. 1/4” thick

B. Pre-drilled

1. 3/8” diameter
2. Hole spacing per ANSI Joint Standard TIA-607-B
3. Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Provide busbars listed by nationally recognized testing laboratory.

E. Size:

1. Telecommunications Main Ground Busbar (TMGB) – 20” x 4” (minimum)
2. Telecommunications Grounding Busbar (TGB) – 12” x 2” (minimum)

2.5 TELECOMMUNICATIONS GROUNDING CONNECTIONS

A. Mechanical Connectors:

1. Connector Body:
   a. High-strength, high-conductivity cast copper alloy
   b. 2-bolt type

2. Bolts, nuts, washers, and lock-washers: 300 series stainless steel
   a. Supplied as part of connector body
   b. Split-bolt connector types are not allowed.

3. Connector:
   a. Meet or exceed UL 467
   b. Clearly marked with catalog number, conductor size, and manufacturer

B. Compression Connectors:

1. Connector Body: Pure wrought copper.
2. Conductivity shall be no less than 99% by IACS Standards.
3. Connector:
   a. Meet or exceed performance requirements of IEEE 837, latest revision.
   b. Filled with an oxide-inhibiting compound.
   c. Clearly marked with manufacturer, catalog number, conductor size, and required compression tool settings.

4. Connection shall be irreversible.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for. #8 AWG and smaller, and stranded conductors for #6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor. Sized as indicated on drawings.

1. Bury at least 24” below grade.

C. Grounding Bus: Install in electrical and communications rooms, in rooms housing service equipment.

1. Install bus on insulated spacers 1”, minimum, from wall; 6” above finished floor.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors
2. Underground and in-concrete Connections: Welded connectors, except at test wells and as otherwise indicated

3. Connections to Ground Rods at Test Wells: Bolted connectors
4. Connections to Structural Steel: Welded connectors

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4” will extend above finished floor.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with feeders and branch circuits.

1. Install a single insulated equipment ground conductor for each branch circuit conduit originating from panelboards.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits
2. Lighting circuits
3. Receptacle circuits
4. Single-phase motor and appliance branch circuits
5. Three-phase motor and appliance branch circuits
6. Flexible raceway runs
7. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install a separate insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping. Ground ductwork of fans serving flammable liquid storage rooms or fume hoods. Install continuous ground around any flexible connections in this ductwork system. Bond lower end of exhaust ducts, vent stacks, etc., which pass through roof.

D. Water Heater: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Duplex receptacles of any amperage: Install separate jumper between grounding terminal on device and metallic box.

F. Size of equipment grounding conductors for branch circuits: As indicated in NEC-70, except minimum size shall be #12 AWG.

G. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NEC-70, except in no instance smaller than #8 AWG.

H. Signal and Communication Equipment: For alarm and other communication equipment (see Telecommunications Grounding System Installation section below for voice and data systems), install install insulated grounding conductor (sized as indicated on drawings) in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4” x 2” x 12” grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

I. Install grounding conductor from each standby-emergency generator to grounding electrode system. Provide flexible jumper between base and isolated generator.

J. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.

K. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and grounding rods arranged as indicated on drawings.

L. Install grounding conductor to luminaires hanging from conduit swivel hangers.

M. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors to pole base. Grounding Conductor: Same size as phase conductors, but not smaller than #10 AWG.

1. Install at each pole within in-ground handhole a driven 1/2” x 8’-0” ground rod, ground clamp and No. 3 stranded copper conductor concealed and attached to pole and base.

3.4 SEQUENCING, SCHEDULING

A. Permanently attach service grounds before permanent building service is energized.

B. Permanently attach equipment grounds prior to energizing equipment.

3.5 INSTALLATION

A. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.

B. Identify all grounding conductors by system and room number of termination at building grounding electrode point.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96A when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service

grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

E. Ground Rods: Drive rods until tops are 2” below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least 3 rods spaced at least one rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12” deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned copper bonding jumper to bond across flexible duct connections to achieve continuity.

J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.

K. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

L. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.

M. Ground Ring: Install a grounding conductor, electrically connected to building structure ground rod and to each indicated item, extending around the perimeter of building.

1. Install tinned-copper conductor as indicated on drawings.
2. Bury ground ring not less than 24 from building foundation and 30 below grade.

N. Concrete-Encased Grounding Electrode: Fabricate according to NFPA 70, using a minimum of 20' of bare copper conductor not smaller than #4 AWG.

1. If concrete foundation is less than 20' long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

O. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.

P. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.

Q. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.6 TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Bonding and Grounding infrastructure as specified.

B. Install products in accordance with manufacturer's instructions. Install Compression Connectors with compression, tool-and-die system, as recommended by manufacturer of connectors.

C. Telecommunications Bonding Conductor: Compression or Exothermic type connections.

D. Locate TGBs and TMGB per drawings.

E. Telecommunications Bonding Conductor shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

F. Insulate busbars from their support.

G. Coordinate with Sections 27 1000, 27 1100, 0 and 27 1500.

3.7 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

1. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal , and at ground test wells. Make tests at ground rods before any conductors are connected.

B. Interpret test results in writing and submit to Engineer.

C. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0533 – Raceway and Boxes for Electrical Systems

B. Section 26 2200 – Low-Voltage Transformers

C. Section 26 2413 – Switchboards

D. Section 26 2416.13 – Lighting and Appliance Panelboards

E. Section 26 2416.16 – Distribution Panelboards

F. Section 26 2816 – Enclosed Switches and Circuit Breakers

G. Section 26 2913 – Enclosed Controllers

H. Section 26 3213 – Engine Generators

I. Section 26 3623 – Automatic Transfer Switches

J. Section 26 5000 – Lighting

1.2 DESCRIPTION

A. Section includes the following:

1. Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.
2. Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.

1.3 REFERENCE STANDARDS

A. AWS D1.1/D1.1M – Structural Welding Code-Steel.

B. ASTM A 36/A 36M – Carbon Structural Steel.

C. ASTM A 325 – Structural Bolts, Steel, Heat Treated, 827/724 MPa(120/105 ksi) Minimum Tensile Strength.

D. ASTM A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.

F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.

G. MFMA-4 – Metal Framing Standards Publication.

H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.

I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).

J. NFPA 70 – National Electrical Code.

K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Raceway and cable supports.
3. Support for conductors in vertical raceway.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components:
   a. Powder-actuated fasteners.
   b. Mechanical-expansion anchors.
   c. Concrete inserts.
   d. Clamps for attachment to structural steel.
   e. Through bolts.
   f. Toggle bolts.
   g. Hanger rods.

B. Shop Drawings: Include concrete anchors application, size, and placement. Include concrete inserts application, size, loading, and placement. Show fabrications and installation details and include calculations for the following:

1. Trapeze hangers. Include product data for components.
2. Steel slotted channel systems. Include product data for components.
3. Fabricated metal equipment support assemblies.

C. Drawings showing specific locations of any suspended loads which exceed 100 lbs within joist chord panel, to be attached to open web steel joist structural members. Include weight supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at points of connection to chord.)

D. Welding certificates and drawings showing specific locations of any weld attachments to structure including weight supported by such attachments.

1. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to “structural work”. Execution of this work may be assigned to General Trades responsible for building structural steel. Cost of this work, however, will remain the responsibility of this Contractor.

E. Schedule of hangers and support devices with support spacing.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel.”

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of 5 times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Finishes
   a. Metallic Coatings:
      1) Factory standard primed, galvanized of electroplated finish and applied according to MFMA-4, for indoor applications.
      2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
   b. Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.

2. Channel Dimensions: Selected for applicable load criteria.
3. Manufacturers:
   a. Allied Support Systems; Power-Strut Unit.
   b. Cooper B-Line, Inc.; A division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corporation.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.
   h. National Pipe Hanger Corporation.
   i. Michigan Hanger Co., Inc.; O-Strut Division.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Raceway and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Raceway: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Concrete Anchors
   a. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.
   b. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.
   c. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.
   d. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.
   e. Anchors shall be zinc plated in accordance with ASTM B633.
   f. Select anchors with load ratings based on cracked concrete conditions.
   g. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      1) Manufacturers:
         a) Hilti Inc.
         b) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
         c) MKT Fastening, LLC.
         d) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
         e) Approved equal
   h. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      1) Manufacturers:
         a) Cooper B-Line, Inc.; A division of Cooper Industries
         b) Empire Tool and Manufacturing Co., Inc.
         c) Hilti Inc.
         d) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
         e) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

H. Beam Clamps: C-clamps are allowed 3/8" or smaller and only for static loading such conduits. Provide locknut for hanging rod at clamp. C-clamps are not allowed for open web steel joist applications nor seismic applications.

I. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

J. Toggle Bolts: All-steel springhead type.

K. Hanger Rods:

1. MSS SP-58; threaded steel, with adjusting and lock nuts; hot-dipped galvanized finish.
2. MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.2 FABRICATED METAL FRAMING EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section “Metal Fabrications” for steel shapes and plates; not be lighter than 12 ga.

C. Finish: Electro-galvanized

D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.3 CONTINUOUS INSERT CHANNELS

A. Length and support capabilities to be suitable for application.

B. Brackets, inserts and accessories suitable for channel insert selected.

C. Manufacturers:

1. Unistrut; Tyco International, Ltd.
2. Cooper B-Line, Inc.; A division of Cooper Industries
3. Michigan Hanger Co., O-Strut Division
4. Anvil International, Inc.
5. Approved equal

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70.

1. Size steel hanger rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

Maximum Loads (lbs)	Rod Diameter (”)	Maximum Pipe Size With Single Rod
730	3/8	2”
1130	1/2	3”

Maximum Loads (lbs)	Rod Diameter (”)	Maximum Pipe Size With Single Rod
1818	5/8	5”

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 3/4” and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor application size and placement shall be reviewed and approved by Structural Engineer prior to installation. Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4” thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4” thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not support raceway by other raceway.

G. Do not support equipment or raceway from metal roof decking or floor decking.

H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.

I. Top or bottom chords of open web steel joists may be used to support loads provided total load within panel does not exceed 100 lbs and load is placed concentric to joist (panel is length of chord between two adjacent diagonal web members at point of connection to chord).

1. C-clamps are not permitted for use in open web steel joist applications.

J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flush and counter flush.

L. Minimize use of concrete anchors and inserts after concrete pour.

M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section “Metal Fabrications” for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE HOUSEKEEPING PADS

A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.

B. Dimensions: 3.5” high and not less than 2” larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section “Cast-in-Place Concrete.”

D. Anchor equipment to concrete housekeeping pad.

1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

E. Coordinate with Architect installation of housekeeping pads on roof.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 Section “Painting” for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 2726 – Wiring Devices

F. Section 27 0553 – Communications Systems Identification

G. Section 27 1100 – Communications Equipment Room Fittings

H. Section 27 1300 – Communications Backbone Cabling

I. Section 27 1500 – Communications Horizontal Cabling

1.2 DESCRIPTION

A. Section includes raceways, fittings, wireways, indoor service poles, outlet boxes, pull and junction boxes, floor boxes, and raceway seals.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. ANSI C80-1 – Rigid Steel Conduit-Zinc Coated (GRS)

C. ANSI C80-3 – Electrical Metallic Tubing-Zinc Coated (EMT)

D. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

E. BICSI TDMM – Telecommunications Distribution Methods Manual, Latest Edition

F. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

G. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

H. NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

I. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit

J. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

K. NFPA 70 – National Electrical Code

L. TIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces

M. UL 1 – Flexible Metal Conduit

N. UL 6 – Electrical Rigid Metallic Conduit-Steel

O. UL 360 – Liquid-Tight Flexible Steel Conduit

P. UL 514A – Metallic Outlet Boxes

Q. UL 514B – Conduit, Tubing, and Cable Fittings

R. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings

S. UL 797 – Electrical Metallic Tubing-Steel

T. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings

1.4 SUBMITTALS

A. Product Data:

1. Raceways
2. Fittings
3. Wireways
4. Outlet boxes
5. Pull and junction boxes
6. Floor boxes
7. Raceway seals

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

C. Closeout Submittals:

1. Project Record Documents:
   a. Record actual routing of raceways larger than 2".
   b. Record actual location and mounting heights of wireways, wall ducts, indoor service poles, floor boxes, tap boxes, outlet, pull and junction boxes.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Protect PVC conduit from sunlight.

C. Comply with manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel

B. Fittings (couplings, conduit bodies, connectors and bushings): NEMA FB 1, UL 514B; steel**;** threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings for conduits 2" and smaller; conduit bodies cover: cast aluminum, with stainless steel screws and neoprene gaskets.

C. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products/Prime Conduit Inc.; O-Z/Gedney; Appleton; Hubbell

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. ANSI C80.3, UL 797; galvanized steel tubing

B. Fittings (couplings, conduit bodies, and connectors): NEMA FB I, UL 514B; steel concrete-tight set-screw type connectors with double locknuts and insulated throat; conduit bodies cover: cast aluminum, with stainless steel screws and neoprene gaskets. Indentor, drive-on, die-cast or pressure cast fittings not permitted.

C. Fittings Manufacturers: Same as manufacturers listed in 2.1.F.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1; interlocked steel

B. Fittings: NEMA FB I, UL 514B; steel

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. UL 360; interlocked steel, with PVC jacket

B. Fittings: NEMA FB 1, UL 514B; steel

2.5 RIGID NONMETALLIC CONDUIT (RNC)

A. NEMA TC 2, UL 651; Schedule 40 (thinwall) PVC and Schedule 80 (thickwall) PVC

B. Fittings: NEMA TC 3, UL 651

2.6 METAL WIREWAYS

A. NEMA 250, UL 870; sheet metal troughs with hinged or removable cover, Type 1 or 3R, unless otherwise indicated.

B. Size: As indicated on drawings.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.

D. Wireways Covers: Screw-cover type

E. Knockouts: none

F. Finish: Manufacturer's standard enamel finish

G. Manufacturers: Hoffman; Square D Co

2.7 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; 1/2" male fixture studs, where required.
2. Concrete Ceiling Boxes: Concrete type

B. Cast-Metal Outlet Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover and threaded hubs

C. Nonmetallic Outlet Boxes: NEMA OS 2

D. Gangable type boxes are not allowed.

E. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds

2.8 OUTLET BOXES FOR COMMUNICATIONS

A. Minimum outlet box size: 4-11/16” square by 2-1/8” deep minimum, with single-gang trim ring, unless otherwise noted on drawings.

1. Total depth of the assembly including the trim ring shall not be less than 2-1/2”.

2.9 PULL AND JUNCTION BOXES

A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel

B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; cast aluminum with ground flange, gasketed cover and stainless steel cover screws

C. Minimum size: 4” square by 2-1/8” deep for use with 1” conduit and smaller; 4-11/16” square by 2-1/8” deep for use with 1-1/4” conduit and larger

D. Sheet Metal Boxes Larger Than 12” in any direction: Hinged cover or a chain installed between box and cover

E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.

F. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds

2.10 PULL AND JUNCTION BOXES FOR COMMUNICATIONS

A. Size: Per TIA-569-B, unless otherwise noted on drawings.

B. Minimum pull box size: 4-11/16” square by 2-1/8” deep, where pull box is used with raceway(s) smaller than 1-1/4” trade size, unless otherwise noted on drawings.

C. Minimum pull box size, where pull box is used with raceway(s) 1-1/4” trade size or larger:

1. For straight pull through: Length of at least 8 times trade-size diameter of largest raceway.
2. For angle and U pulls:
   a. Have distance between each raceway entry inside box and opposite wall of box of at least 6 times trade-size diameter of largest raceway, this distance being increased by sum of trade-size diameters of other raceways on same wall of box; and
   b. Have distance between nearest edges of each raceway entry enclosing same conductor of at least:
      1) Six times trade-size diameter of raceway; or
      2) Six times trade-size diameter of larger raceway if raceways are of different sizes.
   c. For raceway entering wall of pull box opposite to removable cover, have distance from wall to cover of not less than trade-size diameter of largest raceway plus 6 times diameter of largest conductor.

2.11 POKE-THROUGH FITTINGS

A. Basis of design: Legrand/Wiremold Evolution Series

B. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

1. Fire Rating: 2h
2. Service Fitting Type: Surface style
3. Housing: Diecast aluminum cover, finish per architect
4. Configuration for Device Poke-thrus:
   a. Power Poke-thru: Two independent wiring compartments via divider. One 20A duplex receptacle and one spare communications compartment with blank coverplate.
   b. Power / Data Poke-thru: Two independent wiring compartments via divider. One 20A duplex receptacle and one communications device plate for two port outlets.
   c. Fully recessed device activations to allow cable plugs to be enclosed below floor.
   d. Housing to accept one ¾" power conduit and one 1-1/2" communications conduit.

5. Configuration for Furniture Feed Poke-thrus
   a. Furniture Feed Power / Data Poke-thru: Two independent wiring compartments via divider. Cover to have one ¾" screw plug opening and one 1-1/4" screw plug opening.
   b. Housing to accept one 3/4" conduit and one 2" conduit.

2.12 FLOOR BOXES

A. Basis of design: Legrand/Wiremold - Evolution Series

B. Cover: Activation type, Diecast aluminum, flanged, blank or cutout per architect, finish per architect

C. Housing: On grade cast iron box, suitable for concrete floors, fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment

D. Fully recessed device activations to allow cable plugs to be enclosed below floor.

E. Power compartment to accept ¾" conduit and communications compart to accept 1-1/4" conduit. Provide conduits to activated and spare compartments to nearest accessible ceiling.

F. Configuration

1. Power Floor Box: Two independent wiring compartments. One receptacle bracket for 20A duplex receptacle and one spare communications compartment with blank coverplate.
2. Power / Data Floor Box – Two Gang: Two independent wiring compartments. One receptacle bracket for 20A duplex receptacle and one decorator style bracket for communications outlets.
3. Power / Data Floor Box – Four Gang: Four independent wiring compartments. Two receptacle brackets for 20A duplex receptacles and two decorator style brackets for communications outlets.

2.13 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing 4" (±2") raceway movement.

B. Manufacturers: OZ/Gedney AX Series

2.14 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals.

B. Manufacturers: New construction – OZ/Gedney FSK Series

2.15 RACEWAY SEALING FITTINGS

A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series

B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound

C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound

2.16 CABLE SUPPORTS

A. Manufacturers: OZ/Gedney Type S

2.17 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052” or 0.138” thickness and of length to suit application.

C. Integral Water Stop: Manufacturer: Thunderline Corporation

1. High density polyethylene (HDPE). Type Century-Line engineered sleeve with end caps.
2. Steel. Type WS engineered sleeve.

2.18 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate with Architect/Engineer size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.

B. Coordinate with Architect/Engineer cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.

C. Verify with Architect/Engineer all surface raceway installations except in mechanical, electrical, and communications rooms.

D. Coordinate with Architect/Engineer exact locations of floor boxes, where shown on drawings, prior to rough-in.

E. Coordinate routing of through-roof conduits.

F. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.

G. Verify with manufacturer that “touch-up” paint kit kit are available for use.

3.2 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway’s installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Raceways:

1. Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
2. Arrange raceways to maintain headroom and present neat appearance.
3. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.
4. Keep raceways at least 6” away from parallel runs of fuels, hot-water pipes or ductwork. Install horizontal raceway runs above water piping. Install raceways level and square and at proper elevations: 6’-6” minimum headroom, except in exit pathways 7’-0” minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.
5. Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.
6. Avoid exposed raceway runs. Run raceways exposed where impractical or impossible to conceal or where specific approval is obtained. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high-temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.
7. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
8. Do not install raceways in structural or topping floor slabs.
9. Cut raceways square using saw or pipecutter.
10. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 2”, unless sweep elbows required. Bend raceways according to manufacturer’s recommendations. Do not use torches or open flame to aid in bend of PVC conduit.
11. Use raceway fittings compatible with raceways and suitable for use and environment.

12. Provide bushings on all raceways.
13. Raceways minimum sizes:
    a. Minimum raceway size 1/2”, except as noted on drawings.
    b. Minimum home run size: 3/4”, except as noted on drawings.
    c. Minimum size for flexible metal conduit is 1/2” except 3/8” for luminaires.
    d. Minimum size for liquidtight flexible metal conduit is 1/2”

14. Install empty raceways 2-1/2” and larger with 10 ga galvanized fishwire; install 200 lb nylon pull cord in raceways smaller than 2-1/2”; leave at least 12” of slack at each end of pull wire. Cap raceways at both ends.
15. Feed devices on same wall vertically from above or junction box in suspended ceiling.
    a. Do not install horizontal bends in conduit around corners.
    b. Feed devices in exterior or load-bearing walls by horizontal conduit runs.
    c. Where horizontal conduit runs are required or allowed, install conduits from device to device on same wall.

16. Raceways Supports:
    a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
    b. Raceway supports for horizontal or vertical single runs:
        1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
        2) Spring steel type pressure clamps for raceways 3/4” and smaller.
    c. Raceway supports for horizontal and vertical multiple runs:
        1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
        2) Support horizontal runs with appropriately sized rods.
        3) Anchor vertical runs to structure.
        4) Spring-steel type pressure clamps for raceways 3/4” and smaller.
    d. Vertical raceway runs 1-1/4” and larger passing through floors: Support at each floor with pipe riser clamps.
    e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
    f. Secure raceways in metal stud walls to prevent rattling.
    g. Arrange raceway supports to prevent misalignment during wiring installation.
    h. Do not fasten raceways to corrugated metal roof deck.
    i. For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 0529 – Hangers and Supports for Electrical Systems and NFPA 70.

17. Identify raceways per requirements in Section 26 0553 – Electrical Systems Identification.
18. Ground raceways per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
19. Flexible Conduit Connections: Use maximum of 72” of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.

20. Install stainless steel raceway clamps, mounting hardware, supports, hangers, etc., when located in “wet” areas.

21. Communications Raceways:
    a. Minimum communications raceway size: 1", unless otherwise noted on drawings.
    b. Install one raceway from each communications outlet box. Horizontal raceway runs between wall outlet boxes are not allowed.
    c. Terminate raceway above closest accessible ceiling space.
    d. Install insulated bushings on end of each raceway.
    e. Use UL listed metallic grounding clamps, when terminating raceway on cable tray.
    f. Install flush two-gang box with single-gang trim ring for each communications outlet or as noted on drawings.
    g. Install with no more than 180 degrees of bends between pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
    h. Conduit bend radii (minimum) shall be:
        1) Six (6) times internal conduit diameter for conduit 2" or less internal diameter.
        2) Ten (10) times internal conduit diameter for conduit greater than 2" internal diameter.
    i. Conduit bends shall be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
    j. Do not install 90-degree condulets. Install continuous radius sweeps of 45° minimum for 90-degree bends.
    k. Do not install continuous sections longer than 100 ft.
    l. Install nylon pull cord in empty raceways. Leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.

22. Power and low-voltage raceways: Minimum 12" separation when run parallel, cross perpendicular.

B. Wireways:

1. Install in accordance with manufacturer's instructions.
2. Use screws, clips and straps to fasten raceway channel to surfaces.
3. Mount plumb and level.
4. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
5. Supports: Per manufacturer's recommendations.
6. Close ends of raceway channel and unused conduit openings.

C. Boxes:

1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
2. Install the appropriate cover on surface-mounted boxes:
    a. Raised device covers on 4" square and 4-11/16" boxes and handy box covers on handy boxes, etc.
    b. Device covers that are square drawn or square cut on boxes in block.
    c. Tile covers on boxes in tile.
    d. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
    e. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

3. Set outlet boxes parallel to construction and independently attached to same.
4. Do not install back-to-back and through-the-wall boxes. Install with minimum 6” horizontal separation between closest edges of the boxes. Install with minimum 24” separation in acoustic-rated walls and fire-rated walls.
5. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
6. Box Support:
   a. Mount boxes straight.
   b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
   c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
   d. Do not support boxes with tie-wire.
   e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
   f. Support boxes independently of raceways.
   g. Install adjustable steel channel fasteners for hung ceiling outlet box.
   h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
   i. Do not install boxes to ceiling support wires or piping systems.

7. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.
8. Mount boxes in block walls at block joint nearest to indicated height.
9. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
10. When boxes are installed in fire-resistive walls and partitions, provide 24” horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 sq in per penetration and not to exceed a total of 100 sq in per 100 sq ft of wall area. Apply fire stop putty pads acceptable to the fire marshal.
11. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
12. Install boxes to be permanently accessible.
13. Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.
14. Adjust box location up to 10’ prior to rough-in to accommodate intended purpose.
15. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726 – Wiring Devices.
16. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” from ceiling access panel or from removable recessed luminaire.
17. The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.

D. Outlet Boxes for Communications:

1. Install communications outlet boxes for each communications outlet, or as noted on drawings.
2. Coordinate with other trades to maintain 8” clear space (minimum, measured from box centerline) on all sides of wall-mounted telephone outlet box.

E. Pull and Junction Boxes for Communications:

1. Position Communications Pull and Junction Boxes:

a. In any section of conduit longer than 100 ft
b. Where there are bends totaling more than 180 degrees between pull points or pull boxes
c. Wherever there is a reverse bend in run

2. Do not use pull boxes in place of bends on straight section of raceway, unless otherwise shown on drawings.

F. Floor Boxes:

1. Set metal floor boxes level and flush with finished floor surface.
2. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
3. Use cast floor boxes for installations in slab on grade.
4. Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements.
5. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.
6. Power and IT or AV conduits require a minimum 12” separation where routed parallel including entry into floor boxes.

G. Expansion Fittings:

1. Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.
2. Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross expansion joints in structure and raceway runs mechanically attached to 2 separate structures.
3. Use couplings and flexible connection made up of 24” length of flexible metal conduit, where EMT runs across expansion joints in ceiling spaces.
4. Install fitting(s) that provide expansion and contraction for at least 0.0004” per ft of length of straight run per °F of temperature change.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at time of installation.

H. Raceway Penetration Seals:

1. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section “Maintenance of Joint Protection” for materials and installation.
3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.
4. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
5. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1” annual clear space between pipe and sleeve for installing mechanical sleeve seals.

6. Underground, Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves. Size sleeves to allow for 1” annual clear space between raceway and sleeve for installing mechanical sleeve seals.
7. Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
8. Provide chrome- or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.
9. Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.

I. Raceway Sealing Fittings:

1. Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building, where raceway passes between areas of different temperatures such as into or out of cold rooms or freezers, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.
2. Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.
3. Seal raceways entering or passing through “hazardous (classified) areas” as defined in NFPA 70.

J. Raceway and Outlet Boxes Sealing in Bio-sensitive Areas:

1. Where outlet boxes and raceways are recessed mounted, seal box to adjacent wall, ceiling, or floor surface with silicone caulk.
2. Where outlet boxes and raceways are surface mounted:
   a. Seal box to adjacent wall, ceiling, or floor surface with continuous bead of silicone caulk.
   b. Seal both sides of surface-mounted raceway to adjacent surfaces with silicone caulk. Where raceways are threaded rigid steel on minimum 3/4” standoffs, sealing of raceway sides is not required.

3. Install gasketed device cover plates with additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling, or floor surface.
4. After wiring is installed, surround wiring with 1” barrier of silicone caulk around conductors within device box hub.
5. Silicone Caulk: Resistant to microbiological growth.
6. No escutcheons are allowed where raceways pass through walls, floors or ceilings and are exposed in finished areas. Cut and patch holes to within 1/4” of raceway and seal opening with sprayable vinyl, flexible PVC coating equal to Cocoon material.

K. Sleeve Installation for Electrical Penetrations:

1. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Rectangular Sleeve Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50” and no side greater than 16”, thickness shall be 0.052”.
   b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50” and 1 or more sides equal to, or greater than, 16”, thickness shall be 0.138”.

4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors 2” above finished floor level.
7. Size pipe sleeves to provide 1/4” annular clear space between sleeve and raceway, unless sleeve seal is to be installed.

3.4 APPLICATION

A. Raceway uses permitted and not permitted per NFPA 70 requirements and as described below.

B. Rigid Metal Conduit (RMC) permitted to be installed as follows:

1. All locations except corrosive atmospheres
2. Hazardous locations
3. Locations requiring mechanical protection

C. Electrical Metallic Tubing (EMT) permitted to be installed as follows:

1. Interior partitions
2. Above suspended ceilings
3. 1.8 m(6 ft) AFF in exposed areas of mechanical equipment rooms
4. Sizes 2” and smaller except as approved

D. Flexible Metal Conduit (FMC) permitted to be installed as follows:

1. Use flexible metal conduit 2 ft to 4 ft in length for final connections for:
   a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in dry locations.
   b. Final connections to recessed luminaires in lengths not to exceed 6 ft.

E. Liquid Tight Flexible Metal Conduit (LFMC) permitted to be installed as follows:

1. Use liquid tight flexible conduit, 2 ft to 4 ft in length, for final connections to:
   a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in wet locations.
   b. Instruments and control devices

F. Rigid Nonmetallic Conduit (RNC) permitted to be installed as follows:

1. Direct burial, concrete encased
2. Direct burial, in sand fill on bottom and top
3. Corrosive atmospheres
4. Use rigid steel elbows

G. One-half inch raceway permitted:

1. Between controller and its control or pilot device
2. Between lighting switch and nearest outlet for luminaire
3. Control wiring where mounted on equipment where conduit must follow contour of equipment
4. Protective and signal systems where noted
5. Where shown on plans

3.5 RACEWAY WIRING METHODS

A. Underground outside Foundation Wall: Install thinwall nonmetallic conduit; install nonmetallic handholes.

B. In or Under Slab on Grade: Install thickwall nonmetallic conduit; install cast or nonmetallic metal boxes.

C. Outdoor Locations, Above Grade: Install rigid steel conduit; install cast metal outlet, pull, and junction boxes.

D. Wet and Damp Locations: Install thickwall nonmetallic conduit; install cast metal or nonmetallic outlet, junction, and pull boxes. Install flush mounting outlet boxes in finished areas.

E. Dry Locations: Install electrical metallic tubing; install sheet metal boxes; install flush mounting outlet boxes in finished areas; install hinged enclosure for large pull boxes.

F. Exposed Subject to Damage: Install rigid steel conduit.

G. Hazardous Locations: Install rigid steel conduit; install cast metal boxes.

3.6 FIELD QUALITY CONTROL

A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.

B. Replace any damaged component of the raceway system, or install new raceway system.

C. Inspect components, wiring, connections and grounding.

3.7 REPAINTING

A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.

B. Repair damage to paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.

C. Wireways, indoor service poles: Remove paint splatters and other marks from surface; touch-up chips, scratches, or marred finished to match original finish using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.

B. Install knockout closures in unused openings in boxes.

C. Align adjacent wall-mounted outlet boxes for switches and similar devices.

D. Adjust outlet boxes to allow luminaires to be positioned as indicated on drawings.

3.9 CLEANING

A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

END OF SECTION 260533

SECTION 260533.13 - SURFACE RACEWAY SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0553 – Electrical Systems Identification

D. Section 26 2726 – Wiring Devices

E. Section 27 0553 – Communications Systems Identification

F. Section 27 1500 – Communications Horizontal Cabling

1.2 DESCRIPTION

A. Section includes surface metallic raceway system for branch circuits, data network, and other low-voltage wiring.

B. Surface raceway system shall consist of raceway bases, appropriate fittings, and device mounting plates necessary for a complete installation.

C. The lengths of the raceways shown on drawings are illustrative and diagrammatic only and are not accurate. Raceways shall be provided completely installed to match lengths as indicated on architectural lab planning drawings**.** Receptacle circuits shall be pre-wired.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NFPA 70 – National Electrical Code

C. UL 5 - Surface Metal Raceways and Fittings

D. UL 94 – Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.4 SUBMITTALS

A. Product Data: Catalog cuts of components.

B. Shop Drawings:

1. Complete layout, with locations of raceway components.

2. Grounding, branch circuiting, and wiring including locations of service entrances.
3. Receptacle types, manufacturers, and spacing.
4. Receptacle labeling with proper voltage, phase, circuit and panelboard designations, as indicated on drawings.
5. Communication faceplate types, manufacturers and labeling.

C. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Closeout Submittals:

1. Project Record Documents
   a. Record actual locations of surface raceways with receptacle types, locations and circuits identified.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain surface raceways from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

B. Comply with manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metallic Raceways:

1. Basis of design: Legrand/Wiremold ALA 4800 Series

2.2 FABRICATION

A. UL 5, UL 5A, as applicable

B. Fabrication:

1. Aluminum
2. Suitable for use in dry interior locations only.
3. Two-piece with base and snap-on cover
4. Base: two compartments with fixed dividers and cover plate, as indicated on drawings
5. Two-compartment raceway with separate cover for each compartment.
6. Approximately 6” wide by 2-1/4” deep.
7. Covers with cutouts for device plates as shown on drawings.
8. 6” and 12” long device plates with flange to overlap joint of adjacent cover.

C. Prewired Raceways:

1. Wiring devices factory installed, wired, and covers labeled per requirements in Sections 26 0519 – Low-Voltage Electrical Power Conductors and Cables and 26 2726 – Wiring Devices.
2. Raceway sections with 12” pigtails at feed locations, in 2 ft minimum length and customized to match length shown on drawings.
3. Equivalent distance between receptacles; number of receptacles per length of raceway as shown on drawings.
4. Factory installed, NFPA 70 sized, grounding conductors, per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
5. Raceway covers with decorator coverplate for communication outlets.
6. Wiring devices on top and communication outlets on bottom.

D. Material:

1. Aluminum Raceways: Alloy 6063-T5 extruded aluminum, minimum thickness 0.060”
2. Fittings: Same material and metal thickness as linear raceway components.

E. Finish:

1. Aluminum Raceways:
   a. Satin, No. 204 clear anodized 0.004” thick, Class R1 Mil-Spec.

2. Fittings: Color to match linear raceway components.

F. Accessories:

1. Fittings: Available as standard accessories, including external corner units, internal corner units, flat units, blank end units, internal and external elbows, coupling for joining raceway sections, and device mounting brackets and plates.
2. Wire Clips: One for every 2 linear ft of indicated raceway configuration.
3. Corner elbows and tee fittings, to maintain 2" cable bend radius that meets requirements for communications pathways and specifications for fiber optic, coaxial, and high-performance twisted-pair cabling.
4. Device Mounting Brackets and Plates: Plastic device mounting brackets and trim plates allowing installation of indicated wiring devices, and communications outlets horizontally in raceways; trim cover sized to overlap device cut-out in raceway, concealing seams; finished to match linear raceway components; plastic compatible with UL 94; brackets and plates, to match raceway width, and with device mounting holes.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate cover plate openings with the wiring devices contained within.

B. Verify with manufacturer that 'touch-up' paint kit is available for repainting.

C. Coordinate surface raceways installation with architectural lab planning drawings

D. Verify location of raceways with architectural interior elevation drawings.

3.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

A. Install in accordance with ANSI/NECA 1 and manufacturer's instructions.

B. Install flathead screws, clips and straps to fasten surface raceways to substrates, ensuring they are permanently and mechanically anchored. Double-sided adhesive is not acceptable. Mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Install wiring devices of type, quantity and spacing as indicated on drawings.

D. Mount raceways on wall or casework parallel to or at right angles to structure and casework.

E. Feed raceways mounted on walls or casework from a backbox through a wall box connector. Determine point of feed in field and complete wiring connections.

F. Install a chase nipple extension between outlet box on wall and raceway when raceway mounted to support channel for modular casework.

G. Maintain ground continuity throughout entire raceway length per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

H. Do not field cut prewired raceways.

I. Install appropriate backbox extension rings where raceway is mounted to steel slotted channel or by some other method, stood off from wall.

J. Raceway receptacle faceplates shall be labeled per requirements in Section 26 0553 – Electrical Systems Identification.

K. Reinforce each cover section for every 30A receptacle in raceway with two 4-40 Phillips counter-sunk steel screws attached to enclosure near top and bottom of receptacle.

L. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.

M. Raceway base shall be secured using screws. Securing with double-sided adhesive is not acceptable.

3.4 FIELD QUALITY CONTROL

A. Inspect surface raceways for physical damage and proper alignment.

B. Inspect components, wiring, connections, installation, and grounding.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 260533.13

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0520 - Excavation and Backfill

B. Section 26 0543.19 - Handholes and Hardware

1.2 DESCRIPTION

A. Section includes conduits, ducts, and duct accessories for direct buried and concrete encased for underground distribution for electrical power and communications.

B. The terms duct and duct bank, as used in this Section, are defined as follows:

1. Duct: A single underground conduit, encased in concrete or direct buried.
2. Duct Bank: Two or more ducts run together.

1.3 REFERENCE STANDARDS

A. ANSI C2 – National Electrical Safety Code

B. ANSI C80.1 – Rigid Steel Conduit-Zinc Coated (GRC)

C. ASTM F512 – Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduits and Fittings for Underground Installation

D. NEMA TC2 – Electrical Polyvinylchloride (PVC) Conduit

E. NEMA TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. NEMA TC6&8 – PVC Plastic Utilities Duct for Underground Installation

G. NEMA TC9 – Fittings for PVC Plastic Utility Duct for Underground Installation

H. NFPA 70 – National Electrical Code

I. UL 651 – Schedule 40 and 80 Rigid PVC Conduit

J. ULG – Electrical Rigid Metallic Conduit-Steel

1.4 SUBMITTALS

A. Product data for the following:

1. Duct bank materials, including spacers and miscellaneous components
2. Ducts and conduits and their accessories, including elbows, end bells, bushings, seals, bends, fittings, plugs, pull tape, and solvent cement
3. Warning tape

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Closeout Submittals:

1. Project Record Documents:
   a. Record actual routing of conduits and duct banks.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70
2. Comply with ANSI C2
3. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Deliver ducts to project site with end capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUITS

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6, heavy wall, hot dipped, galvanized steel.

B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer, complying with NEMA TC 3 and UL 651, listed for underground use, direct buried, concrete encased.

2.2 DUCT ACCESSORIES

A. Duct Spacers:

1. Rigid PVC interlocking spacers.
2. Factory-fabricated, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling. Horizontal and vertical locking separation as shown on drawings.

B. Elbows: Material to be rigid galvanized steel; minimum bend radius of 36". Coat exterior of elbows with bituminous black paint.

C. Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit; pre-manufactured system for PVC with conduit seals, provisions for roughing into the concrete pour and waste stops, when entering a new building or a new handhole.

D. Bushings: Groundable steel bushings of appropriate sizes on all metal conduits where bell ends are not used; pre-manufactured system for PVC with conduit seals, provisions for roughing into concrete pour and water stops, when entering a new or existing building or a new or existing handhole or pull box.

E. Seals: Mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with manufacturer's instructions, when entering an existing building or handhole or pull box below grade and concrete shall be core drilled for the appropriate size conduit and seal.

F. Plugs: Closure plugs or caps of same material as conduit at ends of unused sections.

G. Pull Tape: Nylon pull tape with measurement markings in uniform lengths in each empty duct.

H. Grounding:

1. Steel grounding bushings, where bell ends are not used.
2. Bonding fitting with bonding strap on steel conduit with end bells.

I. Warning Tape: Underground line warning tape specified in Section 26 0553 - Electrical Systems Identification.

J. Solvent Cement: Recommended by conduit manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6" wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip.
4. Printed legend shall indicate type of underground line.
5. Red tape for electrical and orange tape for communications installations.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into handholes, pull boxes, pad-mounted transformer, and generator with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect. For handholes construction, refer to Section 26 0543.19 – Handholes and Hardware.

C. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.

D. Utility Coordination: When duct lines are being constructed for use by a utility serving the project, consult with them for duct size and quantity, minimum bending radii, maximum distance between pulling points, grounding details, termination arrangement, and other criteria.

E. Duct Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

3.2 EXISTING UTILITIES

A. The existing utilities shown on contract drawings have been plotted from available records. No guarantee is made as to accuracy of locations indicated, and is shown for the benefit of Contractor.

B. Contact all serving utility companies and have them locate their lines prior to commencing work. Telephone “Call Before You Dig”, 48 hours prior to commencing work. Coordinate with Owner all existing utility lines prior to commencing work.

C. Protect shown, visible and located utilities from damage. Promptly repair all active shown, visible and located utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

3.3 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Construction Manager's or Owner's written permission.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends, both horizontally and vertically, at other locations, unless otherwise indicated. All 90-degree sweeps with radius 10 ft or less shall be rigid steel conduit.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane. Do not use conduit that requires the use of couplings for straight runs. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings or rigid metal conduit.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10" o.c. for 5" ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 ft from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct Buried Duct Banks: Install an expansion and deflection fitting in each conduit in area of disturbed earth adjacent to handhole.
3. Concrete Enclosed Duct Banks: Install watertight expansion fitting in each conduit, with internal bonding jumper to allow for 3/4" movement in any direction.
4. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 5 ft outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

F. Expansion Fittings: Provide suitable expansion fittings or other suitable means to compensate for expansion and contraction for raceways crossing expansion joints in structures or concrete slabs between two adjacent structures and between a duct bank and structure. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by manufacturer and as required. Refer to structural drawings for location of expansion joints in structures.

G. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand minimum of 15 psig hydrostatic pressure. Provide watertight entrance sealing device where an underground conduit enters a structure through a concrete roof or membrane waterproofed wall or floor.

H. Fire Stops: Provide fire stop openings around electrical penetrations to maintain fire-resistance rating, where underground raceways penetrate fire-rated walls or floors.

I. Pulling Cord: Install 100 lbf test nylon cord in ducts, including spares. Identify with tags at each end and at any intermediate pull point the origin and destination of each spare duct. Where a duct has been identified with a name and numbers in the Raceway identification table, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each spare duct.

J. Concrete Encased Ducts: Support ducts on duct spacers.

1. Spacer Installation:
   a. Provide spacers close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6” between tiers. Tie entire assembly together using tie wires and reinforcing steel. Install base and intermediate spacers at every coupling point of each duct line for a separation horizontally and vertically per NEC.

2. Concreting Sequence: Pour each run of envelope between handholes or other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer’s written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. Terminate each pour in a vertical plane if more than one pour is necessary, and install 3/4” reinforcing rod dowels extending 18” into concrete on both sides of joint near corners of envelope. Obtain Architect’s approval for the number and location of dowels.

3. Pouring Concrete: Space concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing bars and ties without forming conductive or magnetic loops around ducts or duct groups. Size reinforcing bars and wire ties as indicated on drawings. Provide rebars with minimum of 2” of concrete on sides, top and bottom. Reinforcing bars shown in sections are required throughout.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms of materials and in a manner acceptable to Architect.
6. Minimum Space between Ducts: 3” between ducts and exterior envelope wall, 2” between ducts for like services, and 4” between power and signal ducts.
7. Depth: Install top of duct bank at least 24” below finished grade in areas not subject to deliberate traffic, and at least 30” below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Maintain a grade of at least 4” per 100 ft, either from one handhole or pull box to the next, or from a high point between them, depending on surface contour.
9. Warning Tape: Bury warning tape approximately 12” above all concrete-encased ducts and duct banks. Align tape parallel to and within 3” of the centerline of duct bank. Provide an additional warning tape for each 12” increment of duct bank width over a nominal 18”. Space additional tapes 12” apart, horizontally.
10. Place duct banks on an undisturbed soil base if possible. Where concrete encased duct bank is installed over an extensive area of disturbed earth such that within the periphery of a building, provide a separate concrete base under the duct bank to ensure stability of raceways during installation. Allow this base to set before duct bank is installed.

K. Direct Buried Duct Banks:

1. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
2. Space spacers close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 ft of duct. Secure spacers to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6” between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 20 0520 - Excavation and Backfill.
4. Install backfill as specified in Section 20 0520 - Excavation and Backfill.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4” over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 20 0520 - Excavation and Backfill.
6. Install ducts with a minimum of 3” between ducts for like services and 6” between power and signal ducts.
7. Depth: Install top of duct bank at least 36” below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.

L. Stub-Ups:

1. Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase couplings with 3” of concrete. Concrete encasement applies to concrete encased ducts.

M. Arrangement and Routing:

1. Arrange multiple duct runs substantially in accordance with details shown on drawings. Locate underground ducts where indicated on drawings and grade to the elevations shown on civil drawings.
2. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where duct runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Construction Manager for written instructions before further work is done.
3. Maintain a 12” minimum vertical separation between ducts and other systems at crossings where other utility piping systems are encountered or being installed along a raceway route. Maintain a 12” minimum separation between ducts and other systems in parallel runs. Do not place ducts over valves or couplings in other piping systems. Refer conflicts with these requirements to the Construction Manager for written instructions before further work is done.
4. Provide markers at grade to indicate direction of underground conduits provided under this contract. Provide markers consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction. Provide markers at all bends and at intervals not exceeding 100 ft in straight runs. Use markers made of sheet bronze not less than 1/4” thick embedded in and secured to the top of concrete posts. User markers not less than 10” long and 3/4” wide and marked ELECTRIC CABLES in letters 1/4” high incised into the bronze to a depth of 3/32”.
5. Enter handholes and structures with ducts at right angles.

3.5 WARNING TAPE INSTALLATION

A. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

B. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6” to 8” below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16” overall.

3.6 UNDERGROUND DUCT APPLICATION

A. Service Entrance and Feeders

1. Underground Ducts Below Slab: EPC-40-PVC.
2. Underground Ducts: EPC-40-PVC, encased in concrete.
3. Underground Ducts Crossing Foundations, Paved Paths, Walks, Driveways, and Roadways: EPC-40-PVC, encased in reinforced concrete.

B. Branch Circuits

1. Underground Ducts: EPC-40-PVC.

C. Communications

1. Underground Ducts: EPC-40-PVC.

3.7 EARTHWORK

A. Excavation and Backfill: Comply with Section 20 0520 - Excavation and Backfill, do not use heavy-duty, hydraulic-operated compaction equipment.

3.8 CONCRETE

A. Concrete: 3000 psi, 28-day strength, complying with Division 03 – Concrete, where concrete encased.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Preparation for pulling in conductors:

1. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of

obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

2. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

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SECTION 260543.19 - HANDHOLES AND HARDWARE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 03 3000 – Cast-in-Place Concrete

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0543 – Underground Ducts and Raceways for Electrical Systems

D. Section 26 0543.13 – Excavation and Backfill

1.2 DESCRIPTION

A. Section includes underground utility structures: handholes, pull boxes and accessories for power and communication cable systems.

1.3 REFERENCED STANDARDS

A. AASHTO HB 17 – Standard Specifications for Highway Bridges

B. ANSI C2 – National Electrical Safety Code

C. ASTM A 48/A 48M – Specification for Gray Iron Castings

D. ASTM C 270 – Specification for Mortar for Unit Masonry

E. ASTM C 387 – Specification for Packaged, Dry, Combined Materials for Mortar and Concrete

F. ASTM C 858 – Specification for Underground Precast Concrete Utility Structures

G. ASTM C 891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures

H. ASTM C 1037 – Practice for Inspection of Underground Precast Concrete Utility Structures

I. ASTM E 329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

J. ISO 9000 – Quality Management

K. ISO 10012 – Measurement Management Systems

L. NFPA 70 – National Electrical Code

M. SCTE 77 – Specification for Underground Enclosure Integrity

1.4 SUBMITTALS

A. Product Data:

1. Accessories for underground utility structures.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes
2. Reinforcement details
3. Frame and cover design
4. Grounding details
5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps
6. Joint details

C. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes
2. Cover design
3. Grounding details
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons

D. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

H. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Closeout Submittals:

1. Project Record Documents:
   a. Record actual location of underground utility structures.

2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated

B. Comply with ANSI C2

C. Comply with NFPA 70

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store precast concrete and other factory-fabricated underground utility structures at project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

B. Life and support precast concrete units only at designated lifting or supporting points.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials:

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products
2. Christy Concrete Products
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group

5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.
9. Jensen Precast

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Structural Load Ratings: As specified in Part 3 “Underground Enclosure Application.”

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

1. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly
   b. Cover Handle: Recessed

2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, “ELECTRIC.” or “COMMUNICATION.”
4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12.
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12” vertically and horizontally to accommodate alignment variations.
   a. Windows: Located no less than 6” from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening: Cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie-in to concrete envelopes of ductbanks.
   c. Window openings: Framed with at least two additional NO. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls:
   a. Type and size: Fittings matched to duct or conduit to be terminated.
   b. Fittings: Aligned with elevations of approaching ducts and located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12” wide by 24” long and larger: Inserts for cable racks and pulling-in irons installed before concrete is poured.

2.2 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray

2. Configuration: Designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, “ELECTRIC.” or “COMMUNICATION.”
6. Direct Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings mated with entering ducts for secure, fixed installations in enclosure wall.
8. Handholes 12” wide by 24” long and larger: Factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company
   b. Carson Industries LLC.
   c. CDR Systems Corporation
   d. NewBasis

2.3 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull Box Prototype Test: Test prototypes of pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength of tests of complete pull boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Pull Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Handholes and Pull Boxes in Roadways and Other Deliberate Traffic Paths: Precast concrete AASHTO HB 17, H-20 structural load rating.
2. Handholes and Pull Boxes in Drives, Parking Lots, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Handholes and Pull Boxes in Sidewalk, Landscaping, and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8] structural load rating.

3.2 INSTALLATION OF CONCRETE HANDHOLES AND PULL BOXES

A. Precast Concrete Handhole Installation

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1” sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
4. Concrete: 5000 psi 28-day strength, complying with Division 03 – Concrete.

B. Elevations:

1. Install handholes with bottom below the frost line.
2. Handhole Covers: In paved areas and traffic-ways set surface flush with finished grade. Set covers of other handholes 1” above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least 3 days. Waterproofing materials and installation are specified in Division 07. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.

D. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least 3 days. Dampproofing materials and installation are specified in Division 07 Section “Bituminous Dampproofing.” After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

F. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2” for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.3 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2” sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1” above finished grade.

D. Install handholes and pull boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetration after fittings are sealed.

G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 03 3000 - Cast-in-Place Concrete, with a troweled finish.
2. Dimensions: 10" wide by 12" deep.

H. Install drainage through the bottom of each handhole and pull box via drain lines where indicated.

3.4 GROUNDING

A. Ground utility structures according to Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Provide ground rod in each power system handhole and pull box. Comply with Section 26 0526 - Grounding and Bonding for Electrical Systems.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground utility structures.
2. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Interpret test results in writing and submit to Engineer.

END OF SECTION 260543.19

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SECTION 260553 - ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0516 – Owner Furnished Equipment

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0533 – Raceways and Boxes for Electrical Systems

D. Section 26 0543 – Underground Ducts and Raceways for Electrical Systems

E. Section 26 0923 – Lighting Control Devices

F. Section 26 2200 – Low-Voltage Transformers

G. Section 26 2413 – Switchboards

H. Section 26 2416.13 – Lighting and Appliance Panelboards

I. Section 26 2416.16 – Distribution Panelboards

J. Section 26 2713 – Electrical Metering

K. Section 26 2726 – Wiring Devices

L. Section 26 2816 – Enclosed Switches and Circuit Breakers

M. Section 26 2913 – Enclosed Controllers

N. Section 26 3213 – Engine Generators

O. Section 26 3623 – Automatic Transfer Switches

P. Section 26 4300 – Surge Protective Devices

Q. Section 28 3116 – Multiplexed Fire Detection and Alarm Systems

1.2 DESCRIPTION

A. Section includes the following:

1. Identification for raceway
2. Identification for conductors and control cable
3. Warning labels and signs
4. Instruction signs and posted drawings

5. Equipment identification nameplates
6. Wiring devices identification
7. Miscellaneous identification products

B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.3 REFERENCE STANDARDS

A. ANSI A13.1 – Scheme for the Identification of Piping Systems

B. ANSI C2 – National Electrical Safety Code

C. ANSI Z535.4 – National Standards for Product Safety Signs and Labels

D. 29 CFR – Labor, Part 1910 – Occupational Safety and Health Standards, Section 1910.145 – Specifications for Accident Prevention Signs and Tags

E. NFPA 70 – National Electrical Code

1.4 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1” to 2” wide.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Aluminum Wraparound Marker Labels: Cut from 0.014” thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

F. Metal Tags: Brass or aluminum, 2” x 2” x 0.05”, with stamped legend, punched for use with self-locking nylon tie fastener.

G. Write-On Tags: Polyester tag, 0.010” thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.2 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).

1. Manufacturer: Seton or approved equal

D. Engraved Plastic Signs: Engraving stock, melamine plastic laminate, minimum 1/16” thick for signs up to 20 sq in and 1/8” thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

E. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 7" x 10".

F. Metal-Backed, Butyrate Warning Signs for Exterior Use: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396" galvanized-steel backing; and with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 10" x 14".

G. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING – OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 INSTRUCTION SIGNS AND POSTED DRAWINGS

A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Mounting Frames: Extruded aluminum, 4-point screw mount with 1/8" clear plexiglass cover.

B. Posted Drawings: Print electrical riser diagrams on 20 lb bond paper. (Blueprint paper is not acceptable.) Reduce drawings to approximately 1/2 size using Xerox reduction process. Contact Engineer to obtain updated original plans for printing.

2.4 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8" unless noted otherwise.

B. Stenciled Legend: In non-fading, waterproof, black ink or oil-based, alkyd enamel paint. Minimum letter height shall be 1".

2.5 WIRING DEVICES IDENTIFICATION

A. Refer to Section 26 2726 – Wiring Devices for requirements.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.

1. Minimum Width: 3/16”
2. Tensile Strength: 50 lb minimum
3. Temperature Range: -40°F to 185°F
4. Color: Black, except where used for color-coding

B. Paint: Paint materials and application requirements are specified in Division 09 – Finishes painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange self-adhesive vinyl tape applied in bands.

1. Identify 4” round, 4” square and 4-11/16” junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.

B. Accessible Raceways of Auxiliary Electrical Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System (including covers of pull and junction boxes): Red
2. Security System: Blue and yellow
3. Mechanical and Electrical Supervisory System: Green and blue
4. Telecommunication System: Green and yellow

C. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors or other appropriate number or letter to expedite future tracing and troubleshooting. For single conductor cables, identify phase in addition to the above. Phase identification shall be consistent throughout the system.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape and marker tape. Identify each ungrounded conductor according to source and circuit number.

E. Conductors to Be Extended in the Future and Spare Conductors: Attach marker tape to conductors and list source and circuit number.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control and signal, connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with project drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches
   b. Controls with external control power connections

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
3. Arc Flash Warning Labels: install per NFPA 70 for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.
4. Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.

H. Instruction Signs and Posted Drawings:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" high letters for emergency instructions at equipment used for load shedding.

I. Emergency Electrical System Junction and Pull Boxes:

1. Identify with spray-painted covers: Red

J. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Nameplate Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 1/2" high letters (1/4" where

space is limited) on 1-1/2" high nameplate; where 2 lines of text are required, use nameplates sized 2" high.

b. Outdoor Equipment: Stenciled legend 4" high.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Install nameplates for equipment including, but not limited to, the following:
   a. Panelboards, electrical cabinets, and enclosures
   b. Access doors and panels for concealed electrical items
   c. Electrical switchboards and distribution panelboards including each feeder device within the equipment enclosures.
   d. Transformers
   e. Emergency system boxes and enclosures
   f. Motor-control centers, including each device
   g. Disconnect switches
   h. Enclosed circuit breakers
   i. Motor controllers
   j. Pushbutton stations
   k. Power transfer equipment
   l. Contactors
   m. Remote-controlled switches, dimmer modules, and control devices
   n. Power-generating units
   o. Fire alarm control panel and annunciators
   p. Monitoring and control equipment
   q. Uninterruptible power supply equipment
   r. Non-concealed junction box covers of auxiliary electrical systems

3. Provide the following information on each nameplate:
   a. Equipment name/tag:
      1) Matching the designation from the contract documents, or identifying the load controlled or function of the equipment where no specific tag is shown on the contract documents.
      2) For disconnect switches, use the prefix "SW-" followed by the name of the equipment served, example: "SW-PMP-201."
   b. Equipment operating voltage, phase, wiring configuration, and ampacity:
      1) Example: "208V/3PH/4W/225A"
   c. Source of power supply, including circuit number:
      1) Example: "FED FROM LP-2/45"

K. For switchgear, switchboards, and panelboards, provide a nameplate identifying the color code of wiring within the panel, including the following information:

1. Heading "PANEL VOLTAGE CONDUCTOR COLOR CODING"
2. PHASE A: COLOR OF INSTALLED CONDUCTORS
3. PHASE B: COLOR OF INSTALLED CONDUCTORS
4. PHASE C: COLOR OF INSTALLED CONDUCTORS
5. NEUTRAL: COLOR OF INSTALLED CONDUCTORS
6. GROUND: GREEN

L. For service entrance equipment, provide a nameplate identifying the maximum available fault current and "as of" effective date.

1. Example: "MAXIMUM AVAILABLE FAULT CURRENT 33,500A AS OF 2017/06/15."

M. Access Panel Identification: Furnish typewritten charts with identification and location of access panels serving equipment and incorporate in O&M Manuals.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.

F. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.

G. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.

   1. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: “DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED.”

H. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

I. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

   1. Color shall be factory applied.
   2. Colors for 208/120 V Circuits:
      a. Phase A (left bus in panelboard): Black
      b. Phase B (center bus in panelboard): Red
      c. Phase C (right bus in panelboard): Blue
      d. Neutral: White
         1) Neutral, Phase A; white with black tracer
         2) Neutral, Phase B: white with red tracer
         3) Neutral, Phase C: white with blue tracer
      e. Equipment Ground: Green

3. Colors for 480/277 V Circuits:
   a. Phase A (left bus in panelboard): Brown
   b. Phase B (center bus in panelboard): Orange
   c. Phase C (right bus in panelboard): Yellow
   d. Neutral: Gray
      1) Neutral, Phase A; gray with brown tracer
      2) Neutral, Phase B: gray with orange tracer
      3) Neutral, Phase C: gray with yellow tracer
   e. Equipment Ground: Green

4. Neutral insulation color shall be either white or gray with colored tracer to match color of phase conductor.
5. Field-applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6” from terminal points and in boxes where splices or taps are made. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

J. Aluminum Wraparound Marker Nameplates and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

K. Painted Identification: Prepare surface and apply paint according to Division 09 – Finishes painting Sections.

END OF SECTION 260553

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SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0533 – Raceway and boxes for Electrical Systems

D. Section 26 2726 - Wiring Devices

E. Section 26 5000 – Lighting

1.2 DESCRIPTION OF WORK

A. **Network Lighting Control System shall be a complete system for control, configuration, monitoring, [and reporting via a computer software interface] of lighting systems which meets characteristics and performance requirements as described within this specification.**

1. System shall include system backbone infrastructure, an intelligently distributed digital network of devices that may or may not be integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system.
2. Lighting control system equipment shall be capable of being networked together, enabling communication between devices to provide a fully engineered solution.
3. System shall be configured using control zones defined by common area and function. Sensing and control devices within zones shall provide lighting control as a stand-alone system if network connectivity or communication between control zones is lost, or where a network system is not required such as back of house spaces.

1.3 REFERENCE STANDARDS

A. NFPA 70 – National Electrical Code; National Fire Protection Association

B. NEMA – National Electrical Manufacturers Association

C. UL 20 – General Use Switches, plug load controls

D. UL 916 – Energy Management Equipment

E. UL 924 –Emergency Lighting Equipment

F. FCC - Federal Communications Commission Standards

G. FBC – Florida Building Code

H. ASHRAE 90.1

1.4 SUBMITTALS

A. Bill of Materials: Complete list of parts needed to fully install selected system components.

B. Product Data (for each type of product indicated):

1. Specification sheets with product descriptions.
2. Manufacturer's installation instructions.
3. Operation and maintenance information for normal and emergency operation.
4. Manufacturer shall provide rate sheet for onsite support.

C. Shop and Wiring Drawings:

1. Detailed shop drawings of complete control system to be supplied:
   a. Manufacturer layouts of devices indicating placement of system components and required connections between each, wire counts, and coverage patterns.
   b. One-line diagram(s)
   c. Interconnection diagrams showing field-installed wiring and physical dimensions of each item.
   d. Diagrams showing interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of network protocol.

D. Schedules:

1. Submit low voltage switch schedule for multi zone switches and controllers showing zones/scenes controlled.

E. Service Specification Sheets: Documentation indicating general service descriptions, including startup, training, post-startup support, and service contract terms.

F. Warranty: Copy of applicable warranty

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be Certified and experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

B. Manufacturer Requirements:

1. Manufacturer shall provide 24/7 telephone support by qualified technicians.
   a. Phone Support: Toll free technical support shall be available.
   b. Remote Support: Manufacturer shall offer remote support capability.
   c. Service Contract: Manufacturer shall offer a Service Contract that packages phone, remote, and onsite support calls for project. Response times for each type of support call shall be indicated in terms of service contract included in bid package.

C. Contractor shall ensure that lighting system control devices and assemblies are compatible and can be integrated into a system that operates as described in lighting control notes on drawings

and as described within this specification. Any incompatibilities between devices, assemblies, and controllers shall be resolved between contractor and system provider, as required to ensure proper system operation and maintainability.

D. Performance Requirements: provide system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

E. Code Requirements

1. System components shall be UL listed and certified.
2. System components shall be FCC /IC compliant.
3. System components shall be installed in compliance with National Electrical Codes.
4. Building Codes: Units shall be installed in compliance with FBC and ASHRAE 90.1.
5. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.
6. Components and manufacturing facility where product was manufactured must be RoHS compliant.

F. Coordination

1. Coordinate lighting control components to form an integrated interconnection of compatible components.
   a. Match components and interconnections for optimum performance of lighting control functions.

2. Coordinate Sequence of Operations, Controls Matrix with Architect/Engineer/Lighting Designer. Provide all programming requirements on lighting plans to be evaluated in system submittal

1.6 DELIVERY, STORAGE & HANDLING

A. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.

C. Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.7 WARRANTY

A. Provide manufacturer's warranty for a period of not less than five years from date of substantial completion. Warranty shall include all system hardware and software components. Manufacturer shall make available to Owner new parts, upgrades, and/or replacements for the entirety of warranty period following installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS (ALPHABETICAL)

A. DLM by Wattstopper, Inc.

B. nLight by Acuity Brands, Inc.

C. Greengate by Eaton

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Occupancy Sensing:

1. System shall provide 2 states of occupancy status; occupied or vacant. Based on this status system will adjust lights on or off or to configurable (dimmed) light level as indicated in Sequence of Operations shown on plans.

B. Daylight Control:

1. Photosensor shall trigger changes to light levels with an adjustable delay time when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions by dimming drivers.
2. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photosensors required.
3. System shall react gradually and without flicker upon manual override inputs.

C. Emergency Mode:

1. **System shall monitor utility power and fire alarm system.** Upon loss of utility power **or fire alarm system activation**, system shall immediately adjust emergency lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs.

~~2. System shall interface with building emergency monitoring system fire alarm via a single convenient point and not require multiple connections.~~

D. System Integration:

1. System shall have contact closure interfaces available for integration with shades, projection screen, and AV.

2.3 EQUIPMENT

A. Control Devices

1. Control stations, occupancy sensors, and photosensors shall be low voltage that carry 0-10V control signals for communication.
   a. Wall stations shall:
      1). Provide individual button for each zone. There shall be no buttons that are not associated to a zone. If there are 3 zones but a 3-button control station

is not available by selected manufacturer, provide (1) 2-button and (1) 1-button controls station.

2). Button/Switch plate shall be capable of labeling/engraving and be white unless otherwise indicated on plans.

3). Have pre-set scene control, where indicated on drawings.

4). Have ability to adjust dimming level for each zone where indicated on plans.

5). Mount in standard size wall box (suitable for multi gang installation) or on mounting brackets for low voltage devices.

6). With the exception of areas with stand-alone controls, system shall connect with wall stations.

7). Have touchscreens in place of standard wall stations where required.

b. Occupancy sensors shall:

1). Use passive-infrared (PIR), or dual technology (DT) with a combination of PIR and microphonic or ultrasonic

2). Have adjustable time delay with a maximum setting of 20 minutes and adjustable sensitivity.

3). Contain isolated or remote relay with normally open, normally closed, and common outputs for use with HVAC system, data logging, controlled receptacles or other system control options where indicated in the contract documents.

4). Be provided with ceiling, wall or wall switch style mounting as indicated on drawings.

5). Have daylight filter to ensure PIR sensor is insensitive to short-wavelength waves emitted by the sun (where applicable).

6). Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

7). Provide automatic on/automatic off or manual on/automatic off as indicated on the Network Controls Sequence of Operations with adjustability through network controls software.

c. Photosensors shall:

1). Incorporate photoconductive cell to measure light levels between 1 and 1,000 footcandles.

2). Be adjustable with deadband feature to prevent cycling of lighting from minor changes in cloud cover.

3). Have adjustable time delay range from 3 to 5 minutes.

4). System programming shall not permit lighting systems to be turned on if enough daylight is present.

5). Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

d. Auxiliary Devices

1). Sensor power packs shall:

a). Be self-contained transformer relay modules.

b). Have universal rated voltage inputs 120-277 VAC, 60 Hz.

c). Have dry contact closures rated for switching 120-277 volts, 60 Hz. 20 amp loads.

2). Emergency Bypass/Control Devices shall:

a). UL924 listed and labeled for connection to both normal and emergency lighting power sources.

b). Have universal rated voltage inputs 120-277 VAC, 60 Hz.

c). Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads.

d). Have integral manual test switch.

e). Have auxiliary isolated normally closed contact for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure.

f). Have status indication for presence of normal and emergency power sources and current operational mode (normal or emergency).

g). Be forced into the emergency mode upon loss of normal power sense and turn ON the emergency lighting at full output.
h). Automatically switch emergency lighting ON/OFF as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting ON regardless of the state of any external control device until normal power is restored.
i). Operational temperature range shall be -40°F to 140°F.
j). Device shall have universal mounting; surface, above suspended ceiling or recessed.

e. Exterior Photocells
1). Photocells shall:
a). Have universal rated voltage inputs 120-277 VAC, 60 Hz.
b). Be rated for up to 2,000 watts.
c). Have cadmium sulfide, 1" diameter cell.
d). Have SPST normally closed contacts.
e). Have a minimum delay of 3 minutes to prevent false switching.
f). Operational temperature range shall be -40°F to 140°F.
g). Enclosure shall be die cast zinc, gasketed for maximum weatherproofing.
h). Enclosure shall include positioning lug on top.
i). Mounting shall be for 1/2" conduit nipple.

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-Construction Meeting: Contractor shall meet with lighting equipment supplier, and lighting control equipment supplier to establish compatibility requirements prior to submitting shop drawings for review**.**

1. Verify luminaire-controller compatibility, review exceptions and alternate compliance associated with Specification Conformance Document, and review installation and wiring methodology for optimal function of the control systems.
2. Confirm cover plate labeling and button engraving prior to submitting info to the factory.
3. Confirm matched components and interconnections for optimum performance of lighting control functions and as described in design documents.

B. Site Examination: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.

C. Product Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

A. General

1. Contractor shall coordinate, receive, mount, connect, and place into operation all equipment. Contractor shall furnish conduit, wire, connectors, hardware, control interfaces, devices, AV interfaces, shade control interfaces, and other incidental items necessary for

properly functioning lighting control as described herein and shown on drawings (including but not limited to control devices, fixed output drivers, 0-10V LED drivers and communication wire). Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

2. Contractor shall test that branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize circuits before installation.
3. Wiring Methods:
   a. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4".
   b. Wiring within Enclosures: Comply with NEC . Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
   c. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
   d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
   e. Comply with Division 27 Section 27 1500 Communications Horizontal Cabling for installations utilizing category rated cabling.

B. Control Station Installation

1. Install devices at heights scheduled, and as indicated on drawings. Verify discrepancies prior to rough in.
2. Install wall devices vertically located as follows:
   a. Where located at single-leaf entry doors, locate within 6" of latch side of frame.
   b. Where located at double-leaf entry doors or entry doors without sufficient space at latch side, locate in nearest wall within 6" of edge of door swing. Door shall not block access to device.
   c. For unusual entry door configurations or devices not at entry doors, locate per plans.
3. Where multiple wall stations are collocated, gang and provide single faceplate whenever possible.
4. Install devices plumb, level with finished surfaces and free from blemishes.

C. Sensor Installation

1. Adjust sensitivity to cover area installed as appropriate for mounting location.
2. Set time delay on occupancy sensors that are connected to lighting control system as detailed in Sequence of Operations as shown on plans. Time delays shall be controlled via control software.
3. Install interior photosensor as appropriate for detection type and daylight aperture.
4. Adjust photosensors to maintained illuminance levels specified in the Sequence of Operations as shown on plans.
5. Install sensors a minimum of 6' from HVAC diffusers and chilled beams where possible.

3.3 SYSTEM START-UP AND CONFIGURATION

A. Testing

1. Requests for start-up or technical services shall be at least fifteen (15) business days prior to date desired for service.

2. System Start-up: Manufacturer shall supply factory trained representatives to start-up lighting control system.
3. Upon completion of all line, load and interconnection wiring, and after luminaires are installed and lamped, a qualified factory representative shall completely configure and test system.
4. Test dimming quality:
   a. Check dimmer preset control for proper operation.
   b. Verify dimmers function without producing flicker or audible noise.
   c. Verify dimmers function without interference of audio and visual equipment.

5. Perform the following field tests and inspections with assistance of a factory-authorized service representative:
   a. Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      1). Set preset light levels for all areas
      2). Set time of day Time Clock events
      3). Set Astronomic Time Clock events
      4). Set all other items required for full system functionality per design intent

6. Lighting control devices will be considered defective if they do not pass tests and inspections.
7. Prepare test and inspection reports.
8. Extended Service Coverage: Maintenance agreements shall be available from manufacturer to provide service for system both during and after warranty period.
9. Provide Owner's representatives with system operating manuals.

B. Programming

1. Scene and Level Tuning:
   a. Configure wall stations, sensor functionality, and set system lighting levels as indicated on drawings.

2. Arrange walk-through visits with Owner to fine-tune and develop appropriate additional scenes for system presets.
   a. User interface devices shall have button configuration and programming complete in accordance with contract documents with revisions per shop drawing review process for initial review by users.
   b. Incorporate revisions following user walk-through and provide final engraved buttons.

3. Performance Verification:
   a. Walk through systems with commissioning agent to demonstrate control system meets design intent.
   b. Review system settings with Owner and adjust as necessary to optimize system performance.
   c. Provide documentation that systems were thoroughly tested.

C. Operation and Maintenance Manuals:

1. Contractor shall provide Owner with complete copies in .pdf format of Operations and Maintenance manuals. Each manual shall contain at a minimum:
   a. Detailed as-built shop drawings for system installed

b. Panel schedules for system installed (if applicable)
c. Any controls station schedules for system installed
d. Manufacturers cut sheets for equipment installed
e. Manufacturers complete installation instructions
f. Programming manuals
g. System maintenance requirements and maintenance schedules
h. Manufacturers contact information
i. Manufacturer's warranty

D. Commissioning shall be performed per the requirements for the 2017 FBC – Energy Conservation code section C408.3

3.4 TRAINING:

A. Provider of the service shall train facility staff, or end users, responsible for changing lighting characteristics in building in operation of system and to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training.

B. Provide minimum of three 4-hour sessions at times stipulated by Owner

C. Training and programming shall be completed prior to job closeout

D. Provide a follow-up visit 2 months after occupancy

END OF SECTION 260943

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SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

1.2 DESCRIPTION

A. Section includes dry type distribution and buck-boost transformers rated 600V and less, with capacities up to 300 kVA.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. IEE C57.12.91 – Test Code for Dry Type Distribution and Power Transformers

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NEMA ST 1 – Specialty Transformers (except General Purpose Type)

E. NEMA ST 20 – Dry-Type Transformers for General Applications

F. NFPA 70 – National Electrical Code

G. UL 506 – Specialty Transformers

H. UL 1561 – Dry-Type General Purpose and Power Transformers

I. 10 CFR 431.196 (a) (2) – Energy Conservation Standards and Their Effective Dates

1.4 SUBMITTALS

A. Product Data:

1. Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings:

1. For each transformer size and type:
   a. Physical dimensions, including bolting templates, weight, and center of gravity
   b. Loads, method of field assembly, components, and location and size of each field connection
   c. Wiring Diagrams: Power, signal, and control wiring
   d. kVA rating
   e. Primary taps
   f. Insulation class and temperature rise
   g. Efficiency values measured at 0, 25, 50, 75, and 100% load
   h. Impedance value – X/R and %Z
   i. Sound level
   j. “K” factor listing, where applicable

C. Submit 1/4” scale electrical room floor plans with transformer locations.

D. Manufacturer’s Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Output Settings Report: Record output voltages and tap settings.

G. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations of transformers.

2. Operation and Maintenance Data:
   a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.5 QUALITY ASSURANCE

A. Obtain transformers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. Cutler-Hammer

C. Siemens

D. General Electric

2.2 DISTRIBUTION TRANSFORMERS

A. Fabrication:

1. NEMA ST 20, UL 1561
2. Factory assembled and tested
3. Air-cooled, for 60 Hz service
4. Two winding dry type
5. Coils:
   a. Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish.
   b. Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air.
   c. Materials: Copper
   d. Separate primary and secondary
   e. Internal Connections: Braised or pressure type

6. Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.

7. Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.
8. Transformer neutral visibly grounded to enclosures with flexible grounding conductor.

B. Enclosure:

1. NEMA 250
2. Type 2, unless otherwise indicated to comply with environmental conditions at installed location.
3. Code-gauge steel panel over core and coil.
4. Ventilated (air-cooled): Louvered openings for convection cooling.
5. Cooling and terminal chamber access with both sides and rear obstructed.
6. Manufacturer's lifting eyes or brackets.
7. Finish: Manufacturer's standard gray enamel over prime coat after being degreased, cleaned, and phosphatized.

C. Ratings:

1. KVA Rating: 300 kVA maximum
2. Primary Voltage: 480V, 3-phase, 3 wires.
3. Secondary Voltage: 208Y/120V, 3-phase, 4 wires, unless indicated otherwise on drawings.
4. Insulation Class and Winding Temperature Rise:
   a. Transformers 15kVA and smaller: Class 185°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.
   b. Transformers 25kVA – 112.5kVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.
   c. Transformers above 112.5kVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 30% continuous overload without exceeding 150°C rise.
5. Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.
6. K-Factor Rating: UL 1561, as indicated.

D. Primary Taps:

1. Transformers rated less than 3kVA: None.
2. Transformers rated 3kVA - 15kVA: One 5% above and one 5% below normal full capacity.
3. Transformers rated 15kVA and larger: Two 2.5% above and two 2.5% below normal full capacity, minimum of four taps.

E. Energy Efficiency:

1. Transformers rated 15kVA and larger, except K-rated, quiet type and ultra quiet type:
   a. 10 CFR 431.196 (a) (2) compliant

F. Sound Levels:

1. Minimum of 3 dB less than NEMA ST 20. Maximum average sound levels as follows:
   a. 42 dB for quiet type transformer sizes less than 51kVA.

b. 47 dB for quiet type transformer sizes 51-150kVA.
c. 52 dB for quiet type transformer sizes 151-300kVA.

G. Electrostatic Shielding, where indicated: Each winding with an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Coil leads and terminal strips arranged to minimize capacitive coupling between input and output terminals.
2. Special terminal included for grounding the shield.
3. Shield Effectiveness:
   a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
   c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

2.3 BUCK-BOOST TRANSFORMERS

A. Description: NEMA ST 1, UL 506, UL 1561, same as distribution transformers, except rated for continuous duty and with wiring terminals suitable for connection as autotransformer.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray enamel over prime coat.

2.4 LUGS

A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures.

B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify space indicated for transformers' mounting meets code-required working clearances.

D. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

E. Verify that ground connections are in place and requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems have been met.

F. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 INSTALLATION

A. Install transformers in accordance with ANSI/NECA 1.

B. Install level and plumb within 1/2 degree, and at least 6” from the adjacent wall or structure to insure proper ventilation, in accordance with manufacturer’s written instruction, and in compliance with recognized industry practices.

C. Transformer mounting:

1. Mount transformers on floor, unless noted otherwise on drawings.
2. Floor mounting:
   a. Secure to floor via isolation pads between floor brackets (per manufacturer recommendations) and transformer.
   b. Mount on spring isolator.

3. Wall mounting:
   a. Secure to concrete-and-block wall via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   b. Secure to gypsum walls with independent steel slotted channel supports, secured to floor via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   c. Mount on spring isolator.

4. Suspended mounting:
   a. Suspend transformer enclosures designed for floor mounting, where suspended from structural ceiling, via trapeze constructed of steel slotted channel support system hung via 3/8” minimum steel threaded hanger rods attached to structural members or inserts in structural slab. Each rod to contain spring isolator ceiling hanger. Use locking type nuts in assembly.
   b. Install restraint cables sway bracing sized to resist a horizontal force of 162% of the operating weight acting in any direction for normal power transformers and 212% of the operating weight for emergency/standby power transformers.
   c. Anchor and fasten transformers and their supports to building structural elements by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.

D. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Indicate kVA rating, voltage/phase rating, taps, insulation class and temperature rise, impedance value, sound level, and K-factor listing.

E. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

F. Install transformer in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

3.3 CONNECTIONS

A. Ground transformers according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.4 FIELD QUALITY CONTROL

A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.

B. Interpret test results in writing and submit to Engineer.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings and submit to Engineer.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 h of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10% and not being lower than nameplate voltage minus 3% at maximum load conditions.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5%, at secondary terminals.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 2713 – Electrical Metering

F. Section 26 2813 – Fuses

G. Section 26 4300 – Surge Protective Devices

1.2 DESCRIPTION

A. Section includes free-standing, dead-front type low-voltage distribution switchboards.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 400 – Recommended Practice for Installing and Maintaining Switchboards

B. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

C. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

D. NFPA 70 – National Electrical Code

E. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

F. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications

G. NEMA FU 1 – Low-Voltage Cartridge Fuses

H. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

I. NEMA PB 2 – Dead-Front Distribution Switchboards

J. NEMA PB 2.1 – General Instructions for Proper Handling, Installation and Maintenance of Dead-Front Distribution Switchboards Rated 600 Volts or Less

K. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

L. UL 98 – Enclosed and Dead-Front Switches

M. UL 486A-486B – Wire Connectors

N. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

O. UL 869A – Reference Standard for Service Equipment

P. UL 891 – Dead-Front Switchboards

Q. UL 1053 – Ground-Fault Sensing and Relaying Equipment

1.4 SUBMITTALS

A. Product Data: For switchboard, components and accessories indicated:

1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices.
2. Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.

B. Shop Drawings:

1. For switchboard specified in this Section:
   a. General Arrangement:
      1) Indicate front, plan, and side views of switchboards; access requirements (front, side, rear); overall dimensions and components list; shipping splits and weights.
      2) Front elevation indicating location of devices and instruments.
      3) Sections through switchboard showing space available for conduits.
   b. Conduit entrance locations and requirements.
   c. Nameplate legends.
   d. Configuration, size and number of bus bars for each phase and current rating of buses.
   e. Ground bus.
   f. Neutral bus.
   g. Short circuit ratings of switchboards and overcurrent protective devices, and bus withstand rating.
   h. Instrument details; enclosure types and details.
   i. Wiring diagrams: power, signal and control wiring.
   j. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

2. Contractor to submit 1/4" scale floor plans with switchboard locations and required clearances and service space around equipment.

C. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

F. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations, configurations, and ratings of switchboard and major components on single-line diagrams and plan layouts.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
   d. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Obtain switchboards from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchboards as required to prevent condensation.

B. Deliver switchboards in 42" maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Handle switchboards in accordance with NEMA PB 2.1 and ANSI/NECA 400. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Schneider Square D

B. Eaton Cutler-Hammer

C. Siemens

D. ABB-GE Industrial Solutions

2.2 RATINGS

A. Nominal system voltage: As indicated on the drawings.

B. Main bus continuous amp: As indicated on the drawings.

C. Short circuit current rating: As indicated on drawings.

D. Brace switchboard components to withstand mechanical forces for symmetrical fault current shown.

2.3 CONSTRUCTION

A. NEMA PB 2, UL 891

B. Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure; supporting frame: steel angles rigidly fastened together, with same outside dimensions as the enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Barriers shall be placed such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

E. Incoming lug locations: Bottom

F. Connection to the supply source by conduit and wiring. UL service entrance label.

G. Environmental Limitations:

1. Ambient temperatures: Not exceeding 40°C.
2. Altitude: Not exceeding 2 km
3. Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.

H. Device Mounting and Type:

1. Front accessible switchboard: Front and rear aligned for placement against the wall:
   a. Main device: Fixed (individually) mounted molded-case circuit breaker.
   b. Feeder devices: Panel mounted molded-case circuit breakers.
   c. Devices: Front removable; load connections: Front accessible.

I. Bus:

1. Material: Copper with tin plating; copper: 98% conductivity. The bus bars shall have sufficient cross-sectional area to meet UL 891 temperature rise requirements through actual tests. The bus bars shall be standard density rated for 1000 amperes per square inch copper.
2. Connections:
   a. Bolted:
      1) Not fewer than 4 bolts for each 4” x 4” contact.
      2) Not fewer than 2 bolts for each 2” x 2” contact.
      3) Grade 5 bolts and conical spring-type washers.
      4) Clamp joints are not allowed.

3. Sizing: Standard size, based on 65°C over 40°C.
4. Main Phase Buses: Three phase, 4 wire; fully rated; uniform capacity for entire length of switchboard; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.
5. All feeder device line and load connection straps: Rated to carry current rating of device frame (not trip rating).
6. Support for Buses: Mounted on high-impact, non-tracking insulated supports; joints in the vertical bus are not permitted.
7. Bus arrangement: A-B-C (left to right, top to bottom, front to rear).

J. Ground Bus: Extend length of switchboard.

1. 1/4” x 2” minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection.

K. Neutral Bus: 100% of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

L. Main incoming compartment.

M. Hinged Front Doors: Allow access to metering and accessory compartments; concealed hinges; fastened by head bolts.

N. Cable Supports: For each vertical section.

O. Vertical Insulating Barrier: Between the device compartment and bus compartment.

P. Vertical Insulating Barrier: Between the bus compartment and cable compartment.

Q. Barriers: Between adjacent sections.

R. Hinged Front Doors: Over device compartments, with concealed hinges and fastened by hex head bolts.

S. Hinged Rear Doors and Compartment Covers: With concealed hinges and fastened by hex head bolts.

T. Bus Connections: Extend from load side of devices into rear compartment for connections to outgoing cables.

U. Metering Compartment: Fabricated compartment barriered from rest of the section, with a hinged lockable front cover and removable bus links. Metering equipment: Provisions for mounting current transformers and potential transformers; ~~meter base,~~ metering conductors and miscellaneous appurtenances required.

V. Incoming Pull Sections: Matched and aligned with basic switchboard.

1. Pull Section: Size as indicated on drawings, depth and height to match switchboard. Arrange as indicated on drawings.

W. Future Provisions: Fully equip spaces for future devices with bussing, mounting brackets, supports, and appurtenances, insulated and braced for short circuit currents, with continuous current rating as indicated on drawings. Extension of phase, neutral, and ground buses from both ends.

X. Adequate lifting means.

Y. Dimensions: 90” maximum height, excluding floor sills, lifting members and pull boxes. Length and depth indicated on the drawing are maximum allowed.

Z. Line and Load Terminations: Mechanical type accessible from front only of switchboard, labeled for 75°C copper and aluminum conductors; suitable for number, size and trip ratings.

2.4 SERVICE ENTRANCE

A. UL 869A

B. Switchboards labeled as suitable for use as service entrance equipment, where applicable, with incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

2.5 SHORT CIRCUIT CURRENT RATING

A. Switchboard with minimum short circuit current rating as indicated on drawings.

B. Switchboards: Marked with their maximum short circuit current rating at supply voltage.

C. Switchboards: Fully rated. Series rated switchboards are not acceptable.

2.6 SURGE PROTECTIVE DEVICES (SPD)

A. Furnished under 26 4300 – Surge Protective Devices

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 225 A and below.
2. Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker frame sizes 250 A - 1200 A:
   a. Instantaneous trip
   b. Long- and short-time pickup levels
   c. Long- and short-time time delay adjustments with I^2t response
   d. Ground-fault pickup level, time delay, and I^2t response

3. Current-Limiting Circuit Breakers: No fusible element, frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

B. Circuit Breaker Electronic Trip Units general characteristics:

1. Circuit breakers, with solid-state microprocessor based trip units:
   a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
   b. Trip units shall be removable to allow for field upgrades.
   c. Trip units shall incorporate “True RMS Sensing.”

2. Solid-state elements shall provide functions as indicated above.
3. Adjustments shall be made using non-removable, discrete steps.
4. Sealable transparent cover shall be provided over adjustments.
5. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for five minimum

long-time pickup settings from 0.4 to 1.0 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least three bands.

6. Short-time pickup shall allow for five minimum settings from 1.5 to 10 times Ir. Short-time delay shall be at least three bands with I^2t ON and OFF.
7. Instantaneous settings on the trip units shall be available in five minimum bands from 2 to 15 times In. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.
8. Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
9. Trip unit shall indicate:
   a. Long-time fault
   b. Short-time fault
   c. Instantaneous fault
   d. Ground fault, where provided

10. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
11. Trip unit shall contain means to conduct circuit breaker test, or via separate test kit.
12. Breaker shall be equipped with externally accessible test points to be used for field testing.
13. Trip units shall be provided with the following standard features:
    a. True RMS sensing
    b. LI
    c. LSI
    d. LSIG/Ground-fault trip
    e. Ground Fault Alarm (no trip), with external relay, where required
    f. Adjustable rating plugs

C. Provide permanently mounted locking provisions for all breakers feeding transformers, panelboards, and automatic transfer switches.

D. Ground Fault protection equipment on breakers, where indicated: Integrally mounted relay and trip unit, push-to-test feature and ground fault indicator:

1. Ground-fault protection with at least three adjustable short-time delay settings and three trip-time delay bands; adjustable current pickup with maximum setting of 1200 amps. Arrange to provide protection for the following:
   a. Three-wire circuit or system
   b. Four-wire circuit or system
   c. Four-wire, double-ended substation

2. Trip units shall be capable of the following types of ground-fault protection: source ground return, residual, zero sequence, or modified differential as required. Ground fault sensing systems shall be changed in the field.
3. Neutral current transformers shall be provided for 4-wire system.
4. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.
5. Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

2.8 CUSTOMER METERING

A. Per requirements in Section 26 2713 – Electrical Metering.

PART 3 - EXECUTION

3.1 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

1. Concrete: Per requirements in Division 03 – Concrete.
2. Dimensions: Per requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive switchboards for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchboard mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install switchboard in accordance with NEMA PB 2.1 and ANSI/NECA 400.

B. Switchboard mounting:

1. Bolt switchboards to concrete housekeeping pads, using anchor bolts in accordance with Section 26 0529 – Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.

C. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification for switchboard, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of switchboard using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchboard manufacturer’s name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp,

RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable.

D. Provide framed, printed operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install switchboards in dedicated electrical space per NFPA 70, and as indicated on drawings.

F. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

G. Install fuses in fusible switch at job site per requirements in Section 26 2813 – Fuses.

H. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

I. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.4 CONNECTIONS

A. Ground switchboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect switchboards for physical damage, proper alignment, connections, anchorage and grounding.

B. Test continuity of each circuit.

C. Interpret test results in writing and submit to Engineer.

D. Test switch operators once after energizing.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings to values indicated on drawings.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchboards.

END OF SECTION 262413

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SECTION 262416.13 - LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes circuit breaker type and fusible lighting and appliance branch circuit panelboards as shown on drawings and as scheduled.

1.3 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA FU1 - Low-Voltage Cartridge Fuses

E. NEMA PB 1 - Panelboards

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

G. NFPA 70 - National Electrical Code

H. UL 50 - Enclosures for Electrical Equipment

I. UL 67 - Panelboards

J. UL 248 - Low-Voltage Fuses

K. UL 486A-486B - Wire Connectors

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

M. UL 869A - Reference Standard for Service Equipment

1.4 SUBMITTALS

A. Product Data:

1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:

1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
2. Submit 1/4” scale electrical room floor plans with panelboard locations.
3. Submit features, characteristics, and ratings of individual overcurrent protective devices.

C. Partial Submittals:

1. Breaker panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
2. Fusible panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

D. Manufacturer’s Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations of panelboards and record actual circuiting arrangements.

2. Operation and Maintenance Data:
   a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
   c. Include time-current curves and selectable ranges for each type of overcurrent protective device.

d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain circuit breaker panelboards with overcurrent protective devices, components, and accessories from one source and by single manufacturer.

B. Obtain fusible breaker panelboards with overcurrent protective devices, components, and accessories from one source and by single manufacturer.

C. Regulatory Requirements:

1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials:

1. Furnish Owner with two keys per panelboard.
2. Furnish 20% or minimum of three fuses of each rating and type of fuse installed.
3. Provide a fuse cabinets as indicated on the drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. Cooper Bussman

C. Cutler Hammer

D. Siemens

E. General Electric

2.2 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. NEMA PB 1, UL 67

B. Fabrication:

1. Factory assembled.
2. With door-in-door construction.
3. Incoming feeder lugs: copper and aluminum conductors.
4. Multiple lugs to match number of conductors per phase.
5. Sub-feed (double) lugs, or feed-through lugs where indicated.
6. Filler plates.
7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

C. Panelboard Buses:

1. Copper
2. Ampere rating as scheduled
3. Ground bus: uninsulated, bonded to panelboard cabinet
4. Insulated neutral bus: 100% of phase bus rating

D. Molded-Case Circuit Breakers:

1. NEMA AB 1, UL 489
2. Bolt-on type, labeled for 75°C copper and aluminum conductors
3. Quick-make, quick-break, with thermal-magnetic trip.
4. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
5. Ampere rating as scheduled
6. Listed as Type SWD for lighting circuits
7. Listed as Type HACR for air conditioning equipment circuits
8. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
9. Tandem circuit breakers are not acceptable
10. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated
11. Provide permanently mounted locking provisions for all breakers feeding transformers, panelboards, and automatic transfer switches.

E. Branch Fused Disconnects

1. Visible circuit ON/OFF indication with colored and international symbol markings.
2. Open fuse indication via permanently installed neon indicating light.
3. UL and cUL listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Finger-safe component with trim installed.

5. Mechanical interlock fuse and disconnect to prevent fuse removal while fuse terminals are energized.
6. No special tools required for fuse removal.
7. Bolt-on style bus connectors.
8. Clearly mark device housing with device amperage.
9. Provide permanently installed lockout means on the device for lockout tagout procedures. Provide permanently installed means for locking device in the ON position.
10. Provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 60A, 100A.
11. Provide permanently mounted locking provisions for all fused disconnects feeding transformers, panelboards, and automatic transfer switches.

F. Main and Branch Fusible Overcurrent Protection

1. Overcurrent protective devices: minimum UL listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
2. Branch circuit overcurrent protection: 600Vac UL listed minimum 300kA IR and CSA certified minimum 200kA IR finger-safe fuse with Class J performance characteristics.
3. Main overcurrent protective devices: 600Vac UL listed minimum 300kA IR and CSA certified minimum 200kA IR Class J time-delay fused or Class J performance fuses.
4. Panelboard main fuses: where installed, fused panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

G. Cabinet

1. NEMA 250, UL 50
2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
3. Front (trim) flush or surface mounted as indicated on drawings, with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.

2.3 SERVICE ENTRANCE

A. UL 869A

B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.4 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

D. 480Y/277V lighting panelboards with fuses provided upstream as indicated to achieve interrupting capacity indicated.

2.5 SPARE CONDUITS

A. Spare conduits per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required (i.e., top, bottom, right, left, or combination).

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

F. Coordinate painting of cabinets in finished areas with work performed under Division 09 - Finishes.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:

1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.

3. Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.
4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A – 486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Cover circuit directory with colorless plastic. Coordinator with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.

1. Include panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install three 3/4" spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

M. Install three 3/4" spare conduits stubbed into ceiling space above and below for panelboards that serve loads on levels other than that where the panelboard is located. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Maintain proper phasing for multi-wire circuits.

C. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards.

D. Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 262416.13

SECTION 262416.16 - DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

1.2 DESCRIPTION

A. Section includes circuit breaker type power distribution panelboards as shown on drawings and as scheduled.

1.3 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. NEMA PB 1 - Panelboards

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

G. NFPA 70 - National Electrical Code

H. UL 50 - Enclosures for Electrical Equipment

I. UL 67 - Panelboards

J. UL 486A – 486B - Wire Connectors

K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

L. UL 869A - Reference Standard for Service Equipment

1.4 SUBMITTALS

A. Product Data:

1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:

1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
2. Submit 1/4” scale electrical room floor plans with panelboard locations.
3. Submit features, characteristics, and ratings of individual overcurrent protective devices.

C. Partial Submittals:

1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

D. Manufacturer’s Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Report:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations of panelboards and record actual circuiting arrangements.

2. Operation and Maintenance Data:
   a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
   c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
   d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials:

1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. Cutler Hammer

C. Siemens

D. General Electric

2.2 POWER DISTRIBUTION PANELBOARDS

A. NEMA PB 1, UL 67.

B. Fabrication:

1. Factory assembled
2. Individualized breaker dead-front cover without door.
3. Incoming feeder lugs: copper and aluminum conductors
4. Multiple lugs to match number of conductors per phase

5. Sub-feed (double) lugs, or feed-through lugs where indicated
6. Filler plates
7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

C. Panelboard Buses:

1. Copper
2. Ampere rating as scheduled
3. Ground bus: uninsulated, bonded to panelboard cabinet
4. Insulated neutral bus where applicable: 100% of phase bus rating

D. Molded-Case Circuit Breakers:

1. NEMA AB 1, UL 489
2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors
3. Quick-make, quick-break, with thermal-magnetic trip and electronic (solid-state microprocessor-based) trip.
4. Equipped with individually insulated, braced, and protected connectors
5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
6. Ampere rating as scheduled
7. Front face flush with each other
8. Large, permanent, individual circuit numbers affixed to each breaker in uniform position
9. Tripped indication clearly shown by breaker handle taking position between “ON” and “OFF.”
10. Listed as Type HACR for air conditioning equipment circuits
11. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
12. For 225A frame size and below: thermal-magnetic trip
13. For 250A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
14. Provide permanently mounted locking provisions for all breakers feeding transformers, panelboards, and automatic transfer switches.

E. Cabinet

1. NEMA 250, UL 50
2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
3. Four-piece front (trim) surface mounted without door with breakers exposed.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel
7. Manufacturer’s standard gray enamel finish over prime coat.

2.3 SERVICE ENTRANCE

A. UL 869A

B. Panelboards labeled as suitable for use as service entrance equipment where applicable and must include connection for bonding and grounding of neutral conductor.

2.4 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:

1. Install panelboard anchorage devices.

2. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
3. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
4. Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.
5. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform, with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A –486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) affixed to outside cover of each panelboard. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Indicate panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Interpret test results in writing and submit to Engineer.

C. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energizing panelboards.

D. Check panelboards for electrical continuity of circuits and for short-circuits prior to energizing.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint to Owner.

3.7 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 262416.16

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SECTION 262713 - ELECTRICAL METERING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 2413 – Switchboards

F. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes equipment for energy and demand metering ~~**by a utility company** and~~ by Owner. It also includes options that provide for monitoring ~~or automatic control of demand~~ at a remote location.

1.3 REFERENCE STANDARDS

A. ANSI C12.1 – Code for Electricity Metering

~~B. ANSI C12.7 – Requirements For Watthour Meter Sockets~~

~~C. ANSI C12.9 – Test Switches For Transformer-Rated Meters~~

~~D. ANSI C12.10 – Watthour Meters~~

~~E.~~**B.** ANSI C12.11 – Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)

~~F.~~**C.** ANSI C12.18 – Protocol Specification For ANSI Type 2 Optical Port

~~G.~~**D.** ANSI C12.19 – Utility Industry End Device Data Tables

~~H.~~**E.** ANSI C12.20 – Electricity Meters-0.2 and 0.5 Accuracy Classes

~~I. ANSI C39.1 – Requirements, Electrical Analog Indicating Instruments~~

~~J. IEEE C37.90.1 – Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus~~

~~K.~~**F.** IEEE C57.13 – Standard Requirements for Instrument Transformers

~~L. IEEE C62.11 – Metal-Oxide Surge Arresters for Alternating Current Power Circuits~~

~~M. IEEE C62.41.1 – Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits~~

~~N. IEEE C62.41.2 – Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits~~

~~O. IEEE C62.45 – Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits~~

~~P.~~**G.** NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

~~Q.~~**H.** NECA 400 – Recommended Practice for Installing and Maintaining Switchboards

~~R.~~**I.** NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

~~S.~~**J.** NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

~~T. NEMA AB 3 – Molded-Case Circuit Breakers and Their Applications~~

~~U.~~**K.** NEMA EI 21.1 – Instrument Transformers for Revenue Metering (110KV BIL and Less)

~~V.~~**L.** NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

~~W. NEMA LA 1 – Surge Arresters~~

~~X.~~**M.** NEMA PB 2 – Dead-Front Distribution Switchboard

~~Y.~~**N.** NFPA 70 – National Electrical Code

~~Z.~~**O.** UL 50 – Standard for Enclosures for Electrical Equipment (1995)

~~AA.~~**P.** UL 98 – Enclosed and Dead-Front Switches

~~BB. UL 414 – Standard for Meter Sockets (1999)~~

~~CC.~~**Q.** UL 467 – Grounding and Bonding Equipment

~~DD.~~**R.** UL 486A-486B – Wire Connectors

~~EE. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures~~

~~FF.~~**S.** UL 891 – Dead-Front Switchboards

~~GG.~~**T.** ASTM D1535 – Standard Practice for Specifying Color by the Munsell System

1.4 SUBMITTALS

A. Product Data: For metering equipment, components and accessories indicated:

1. Include data on features, components, and complete description; submit catalog cut sheets showing electrical characteristics and ratings.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe operating sequences, both automatic and manual.

B. Shop Drawings:

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: Power, signal, and control wiring. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field installed wiring, and show circuit protection features.

C. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations and ratings of metering equipment on single-line diagrams and plan layouts.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include manufacturer's written instructions for testing.
   c. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain metering equipment from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

~~**1.6 DELIVERY, STORAGE, AND HANDLING**~~

~~A. Receive, store, and handle modular meter center as specified in NECA 400. Use factory installed lifting provisions. Handle carefully to avoid damage to assembly internal components, enclosure, and finish.~~

~~1.7~~1.6 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

~~1.8~~1.7 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR UTILITY COMPANY ELECTRICAL METERING

A. Cabinets:

1. Meter Cabinets: Comply with requirements of electrical power utility company.

2.2 EQUIPMENT FOR OWNER ELECTRICAL METERING

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Manufacturers:
   a. Square D
   ~~b. General Electric~~
   ~~c.~~**b.** Siemens
   ~~d.~~**c.** Cutler-Hammer
   ~~e.~~**d.** Approved equal

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase Currents, Each Phase: +/-0.5%
   b. Phase-to-Phase Voltages, Three Phase: +/-1%
   c. Phase-to-Neutral Voltages, Three Phase: +/-1%
   d. Megawatts: +/-2%

e. Megavars: +/-2%
f. Power Factor: +/-2%
g. Frequency: +/-0.5%
h. Megawatt Demand: +/-2%; demand interval programmable from 5 to 60 minutes
i. Accumulated Energy, Megawatt Hours: +/-2%. Accumulated values unaffected by power outages up to 72 hours
j. Maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a one-year period.
k. Total Harmonic Distortion, Amperes
l. Total Harmonic Distortion, Volts
m. Individual Amperage Harmonics through the 63rd
n. Integral Communications Port

~~3.~~ Mounting: Display and control unit flush or semiflush, mounted in instrument compartment door.

~~B. Analog Meters (Ammeters, Voltmeters, and Power Factor Meters): ANSI C39.1:~~

~~1. Manufacturers:~~
~~a. Square D~~
~~b. General Electric~~
~~c. Siemens~~
~~d. Cutler-Hammer~~
~~e. Approved equal~~

~~2. Meters: Taut-band, indicating type, switchboard class; 4" diameter or **[**4-1/2"**] [**6"**]** square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.~~
~~a. Ammeters: 5 A, full-scale movement, with a scale of zero to the primary rating of the CTs.~~
~~b. Voltmeters: Direct reading where PTs are not shown or have a 150V, full-scale movement where PTs are shown; cover and expanded-scale range of nominal voltage plus 10 percent.~~
~~c. Feeder Ammeters: 2-1/2" minimum size with 90- or 120-degree scale. Meter and transfer device with an off position, located on overcurrent device door for indicated feeder circuits only.~~

~~3. Instrument Switches: Rotary type with off position:~~
~~a. Ammeter Switches: Permit reading of current in each phase and maintain current transformer secondaries in a closed-circuit condition at all times.~~
~~b. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.~~

~~4. Watt-Hour Meters: Flush or semiflush type, rated 5 A, 120 V, 3 phase, 3 wire, 2-1/2 elements on 3-phase, 4-wire wye systems and 2 elements on 3-phase, 3-wire delta systems; 15 **[30-]** minute indicating demand register; and provision for testing and adding pulse initiation.~~

~~5.~~**3.** ~~Recording Demand Meters: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.~~

~~C.~~**B.** Instrumentation:

1. Manufacturers:
   a. Square D
   ~~b. General Electric~~
   ~~c.~~**b.** Siemens
   ~~d.~~**c.** Cutler-Hammer
   ~~e.~~**d.** Approved equal

2. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
   a. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
      1) 600 V and below: external PTs not required; fused potential connection.
   b. Current Transformers: ~~[~~Bar~~] [Window]~~ type; ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments; shorting test blocks: 10 poles – 4 potential and 6 current, mounted with meter or in accessible location.
   c. Control-Power Transformers: Dry type~~, mounted in separate compartments for units larger than 3 kV.~~
   d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker ground-fault protection.

~~D.~~**C.** Data Communications:

1. Means to transmit data to central control ~~[~~and monitoring~~]~~ system.
   ~~a. [Two RS-485 and one RS-232 communication ports.]~~
   ~~b. [Output communication of the meter through a serial RJ-45 connection.]~~
   a. ~~[~~Digital communication port connection in **BACNET**~~MODBUS~~ IP **ethernet** compatible communication protocol**s** to communicate with Building Automation System (BAS) via Ethernet**. Coordinate final protocol and connection type with BAS system provider.**~~.]~~
      ~~c.~~**1) Transmit energy (KWH), demand (KW) and power factor (PF) for all loads being metered.**
   ~~d. **[Integral communication module port with functions and features compatible with power monitoring and control system specified in Section 26 0913 – Electrical Power Monitoring and Control.]**~~
   ~~e.~~**b.** Keypad and scrollable display for local reading of measured values.

~~E. Kilowatt-Hour Meters:~~

~~1. Manufacturers:~~
   ~~a. E-MON L.P~~
   ~~b. National Meter Industries, Inc.~~
   ~~c. Osaki Meter Sales, Inc.~~
   ~~d. Power Measurement~~
   ~~e. Square D~~
   ~~f. Cutler-Hammer~~
   ~~g. General Electric~~
   ~~h. Siemens~~
   ~~i. Approved equal~~

~~2. Kilowatt-Hour Meter: Electronic **[single] [three] [single- and three-]** phase meters, measuring electricity used.~~

a. ~~Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.~~
b. ~~**[Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.]**~~

3. ~~Kilowatt-Hour/Demand Meter: Electronic **[single] [three] [single- and three]** phase meters, measuring electricity use and demand.~~
   a. ~~Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.~~
   b. ~~**[Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.]**~~
   c. ~~[DCG1]Demand Signal Communication Interface: Match signal to **[building automation system] [_____]** input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.~~
   d. ~~Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.~~
   e. ~~Enclosure: NEMA 250, Type **[1] [3R]** minimum, with hasp for padlocking or sealing.~~
   f. ~~Identification: Comply with Section 26 0553 – Electrical Systems Identification.~~
   g. ~~Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.~~
   h. ~~Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.~~
      1) ~~Type: **[Split] [and] [solid]** core.~~
   i. ~~Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.~~
   j. ~~Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.~~
   k. ~~**[Solid State Breakers for Energy Monitoring (provided under other specification sections). Identified breakers shall monitor energy use and report to the building automation system.]**~~

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate adjustment and programming of metering equipment with manufacturer.

B. Instruct manufacturer about the location of incoming lugs (i.e., top or bottom feed based on incoming feeder entrance location).

~~C. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:~~

1. ~~Concrete: Per requirements in Division 03 – Concrete.~~
2. ~~Dimensions: Per requirements in Section 26 0529 – Hangers and Supports for Electrical Systems.~~

~~D.~~**C.** Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.

~~E.~~**D.** Verify with manufacturer that “touch-up” paint kit is available for repainting.

~~F. Coordinate utility company metering equipment requirements.~~

~~G. **[Coordinate meter data transmission with [campus power monitoring system (CPMS)] [Building Management System (BMS)] [Supervisory Control and Data Acquisition (SCADA) System] to integrate metering components with system architecture.**~~

~~H.~~**E.** Coordinate meter data transmission with ~~[~~Building Management System (BMS~~)] [Supervisory Control and Data Acquisition (SCADA) System]~~ to integrate electrical system metering data with ~~[CPMS] [~~BMS~~] [SCADA] GUI~~ and ~~[~~LEED~~]~~ ~~[~~**and** Energy Code~~]~~ reporting requirements.~~]~~

3.2 EXAMINATION

A. Examine areas and surface to receive modular meter center for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for modular meter center mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Comply with installation requirements in NECA 1.

~~B. Install utility company metering equipment per requirements in Section**[s] [26 1113 – Primary Unit Substations] [Section 26 2300 – Low-Voltage Switchgear] [Section 26 2413 – Switchboards]**.~~

~~C. Install current transformer cabinets, meter cabinets or meter sockets to comply with requirements of electrical power utility company. Install empty conduits for metering leads and extend grounding connections as required by utility company.~~

~~D. Install modular meter center in accordance with NECA 400.~~

~~E. Modular meter center mounting and seismic restraints:~~

~~1. Install modular meter center anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State **[Commonwealth]** of **[XXX]**, and to comply with Section 26 0548 – Vibration and Seismic Controls for Electrical Systems for seismic criteria.~~
~~2. Bolt modular meter center to concrete housekeeping pad, using anchor bolts in accordance with Section 26 0529 – Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pad.~~

~~3. Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 0548 – Vibration and Seismic Controls for Electrical Systems.~~

~~F.~~**B.** Install engraved plastic nameplates under provisions of Section 26 0553 - Electrical Systems Identification for modular meter center, every instrument, overcurrent protective device, and disconnect device. Attach nameplate to exterior of modular meter center using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. ~~Indicate modular meter center manufacturer's name and drawing number, name, amperage, voltage, phase, number of wires, short-circuit current rating (amp, RMS symmetrical and MVA three-phase symmetrical), and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include tenant name, load served, voltage/phase rating, and fuse size and type, when applicable.~~

~~G. Install modular meter center in dedicated electrical space per NFPA 70, and as indicated on drawings.~~

~~H.~~**C.** Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

~~I.~~**D.** Install fuses in fusible switch at job site per requirements in Section 26 2813 – Fuses.

~~J.~~ ~~**[Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 26 4300 – Surge Protective Devices.]**~~

~~K.~~**E.** Mount meters in the locations indicated on the drawings. Mounting height: 5'-6" or less from finished floor.

~~L. Transformer-Rated Meter:~~

~~1. Install electricity metering equipment in or on pad-mounted transformers provided under Section 26 1219 – Pad-Mounted, Liquid-Filled Medium-Voltage Transformers:~~
~~a. Install current transformers on secondary spade terminals.~~
~~b. Install fuse block inside low-voltage compartment (for potential wiring inputs to watthour meter).~~
~~c. Install meter socket on exterior of low-voltage compartment.~~
~~d. Install solid-state electricity meter in meter socket.~~
~~e. Install fuses in fuse block, one for each phase.~~
~~f. Connect meter KYZ pulse output to BAS panel in building.~~

~~M. Self-Contained Meter:~~

~~1. Install meter socket on **[concrete post] [building]** as indicated.~~
~~2. Install solid-state electricity meter in meter socket.~~
~~3. Connect meter KYZ pulse output to BAS panel in building.~~

~~3.4 FIELD WIRING~~

~~A. Install field wiring to complete the electricity metering installation.~~

~~1. Transformer-rated meter:~~

~~a. Current transformer wiring shall be #12 AWG minimum size. Where distance to meter exceeds 22 ft, increase wire size to #10 AWG to reduce the burden on the metering circuit.~~

~~b. Potential wiring shall be #14 AWG.~~

~~c. Color coding: Same for current and potential wiring. A phase – black; B phase – red; C phase – blue; Neutral – white; Ground – green. Identify all wiring with plastic sleeve wire markers. Cloth markers are not acceptable.~~

~~d. Neatly train and lace wiring for metering installation within pad-mounted transformer compartment and meter socket enclosure using nylon cable ties.~~

~~2. **[Transformer-rated] [Self-contained]** meter:~~

~~a. Field wiring for building automation system (BAS) connection to solid-state electricity meter:~~

~~1) Conduit: Install a 3/4" conduit routed underground from **[low-voltage compartment of pad-mounted transformer] [meter]** to BAS panel in the building; terminate conduit within 12" of BAS panel.~~

~~2) Communications Wiring: In the 3/4" conduit, install a 3-conductor communications cable as recommended by meter manufacturer. Connect one end to cable lead from meter KYZ pulse initiator module. Leave 4 ft excess cable coiled at opposite end for connection to BAS panel.~~

~~3.5~~3.4 CONNECTIONS

A. Ground metering equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

C. Bond meter socket enclosure to grounding facilities at pad-mounted transformer. Grounding equipment per UL 467 requirements.

~~3.6~~3.5 FIELD QUALITY CONTROL

A. Test continuity of each circuit.

B. Interpret test results in writing and submit to Engineer.

C. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 1.5 hp minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for 8 h, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.

5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

D. Verify that correct multiplier is indicated on face of meter.

E. Verify that current transformer secondary circuits are intact.

F. Inspect indicating devices for proper operation.

~~3.7~~3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

~~3.8~~3.7 ADJUSTING

A. Adjustment and programming of metering equipment: By factory-authorized representative.

B. Compare meter display readings with readings taken with clamp on ammeter and hand held volt-meter.

C. Make adjustments as necessary.

~~3.9~~3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

~~3.10~~3.9 DEMONSTRATION

A. Provide training session by manufacturer for up to 4 h at a job location, to train the Owner's personnel in the operation and maintenance of metering equipment.

END OF SECTION 262713

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 - Grounding and Bonding for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

1.2 DESCRIPTION

A. Section includes general-use snap switches, receptacles, cord and plug sets and device cover plates.

1.3 REFERENCE STANDARDS

A. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits

B. IEEE C62.45 – Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits

C. NECA 1 – Good Workmanship in Electrical Contracting

D. NFPA 70 – National Electrical Code

E. NEMA FB 11 – Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations

F. NEMA WD-1 – General Color Requirements for Wiring Devices

G. NEMA WD-6 – Wiring Devices - Dimensional Requirements

H. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

I. UL 20 – General-Use Snap Switches

J. UL 498 – Attachment Plugs and Receptacles

K. UL 943 – Ground-Fault Circuit-Interrupters

L. UL 1010 – Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

M. UL 1436 – Outlet Circuit Testers and Similar Indicating Devices

N. UL 1449 – Transient Voltage Surge Suppressors

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations and ratings of wiring devices.

2. Operation and Maintenance Data:
   a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
   b. Include source and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain wiring devices from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Wiring Devices; a division of Cooper Industries, Inc.

B. Hubbell Incorporated; Wiring Device-Kellems

C. Leviton Manufacturing Company, Inc.

D. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.2 GENERAL-USE SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches: Heavy-duty (specification grade); back and side wired; flush or surface mounting; Body and Handle: thermoplastic with toggle handle; for connection to copper or copper-clad conductors:

1. Ratings:
   a. Voltage: 120-277V, AC
   b. Current: 20 A

2. Single pole
3. Locking Type: Designed to prevent tampering and unauthorized switching.
4. Single-Pole, Double-Throw, Momentary Contact, Center-Off: For use with mechanically held lighting contactors.
5. Weatherproof: Toggle switch

2.3 RECEPTACLES

A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Receptacles: 125 V, 20A, heavy-duty (specification grade); back and side wired; flush or surface mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; duplex and single as indicated on drawings.

1. Ground Fault Circuit Interrupter (GFCI):
   a. Additional compliance with UL 943 Class A.
   b. Leakage current trip level: 4 to 6 mA.
   c. Trip time: .025 seconds nominal.
   d. Feed-through type
   e. Reverse line-load function to prevent GFCI from functioning if wired incorrectly.
   f. Indicator Light: Lighted when device is tripped.

2. Transient Voltage Surge Suppression (TVSS):
   a. Additional compliance with UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

b. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
c. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate devise is “active” or “no longer in service.”

3. Twist-locking:
   a. NEMA WD 6 configuration As indicated on drawings.

4. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30%.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 DEVICE COVER PLATES

A. Single and combination types to match corresponding wiring devices:

1. Attachment: Metal screws with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with while-in-use hinged cover, and listed and labeled for use in “wet locations.”

B. Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with weatherproof while-in-use hinged cover.

2.6 FINISHES

A. Color:

1. Switch handles, receptacle faceplates, and device cover plates: white, except as follows:
   a. Switch handles, receptacles, and faceplates connected to Emergency or Standby Power System: Red
   b. TVSS Receptacles: Blue

PART 3 - EXECUTION

3.1 COORDINATION

A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.

B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.

C. Cord and Plug Sets: Match equipment requirements.

D. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the device cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

3.2 EXAMINATION

A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

A. Clean debris from outlet boxes.

3.4 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.

C. Device Installation:

1. Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6” in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than #12 AWG are installed on 15A or 20A circuits, splice #12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install devices plumb, level with finished surfaces and free from blemishes.
11. Install lighting switches vertically on latch side of door within 6” of frame edge.
12. Install devices above counters, 2” to the bottom of device above countertop or backsplash. Install all devices at same height above any one counter or fixed cabinet.
13. Install special purpose receptacles and switches according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.
14. Install weatherproof GFCI receptacles:
    a. Within 25’-0” of roof-mounted mechanical equipment
    b. Outdoors
    c. As indicated on drawings

15. Group adjacent switches under single, multigang wall plates.
16. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Ground per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

D. Installation Orientations:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install switches with handle operating vertically, with “ON” position up.
3. Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.

E. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Arrangement of Devices:

1. Unless otherwise indicated or where space problem occurs, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.5 IDENTIFICATION

A. Comply with Section 26 0553 – Electrical Systems Identification.

1. Switches and Receptacles: Use hot, stamped lettering on face of cover plate, and durable wire markers or tags inside outlet boxes.
   a. Receptacles: Label shall indicate receptacle voltage, phase, and amperage for receptacles other than 20A, 120 V, at top of cover plate, and panel and circuit number at bottom of cover plate.
   b. Switches: Label shall indicate switch voltage, phase, and amperage at top of cover plate, and panel, circuit number and switch designation at bottom of cover plate.

2. Engrave cover plates on all Owner-furnished equipment and equipment furnished under other divisions of these specifications with panelboard, and circuit number as specified in this section. This includes custom casework with electrical devices, etc..

3.6 FIELD QUALITY CONTROL

A. Inspect wiring devices for defects.

B. Operate wall switches with circuits energized and verify proper operation.

C. Verify receptacle device is energized.

D. Perform tests and prepare test reports:

1. Test receptacle devices for proper polarity:
   a. Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.

2. Test each GFCI receptacle device for proper operation:
   a. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. “TEST” button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.

3. Test Instruments: Use instruments that comply with UL 1436.
4. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

E. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 V to 132 V.
2. Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

F. Interpret test results in writing and submit to Engineer.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Remove excess plaster from interior of outlet boxes.

B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 2413 - Switchboards

B. Section 26 2416.13 - Lighting and Appliance Panelboards

C. Section 26 2816 - Enclosed Switches and Circuit Breakers

D. Section 26 2913 - Enclosed Controllers

1.2 DESCRIPTION

A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.3 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses

B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements

C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses

D. UL 248-5 - Low-Voltage Fuses - Part 5: Class G Fuses

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses

H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses

I. UL 512 - Fuseholders

1.4 SUBMITTALS

A. Product Data:

1. Submit the following for each fuse type and size indicated:

a. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.
b. Time-current curves, coordination charts and tables, and related data.
c. Let-through current curves for fuses with current-limiting characteristics.
d. Fuse size for each elevator disconnect switch.

B. Closeout Submittals:

1. Project Record Documents:
   a. Record actual class, size, and location of fuses.

1.5 QUALITY ASSURANCE

A. Obtain fuses from one source and by single manufacturer.

B. Comply with NFPA 70 for components and installation.

1.6 MAINTENANCE

A. Extra Materials:

1. Furnish to the Owner a quantity of spare fuses equal to 25% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
2. Furnish 2 fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Bussmann

B. Mersen

C. Littelfuse

D. Edison Fusegear

2.2 CARTRIDGE FUSES

A. NEMA FU 1, UL 248-1.

B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.

C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-4	CC	600	0-30	200,000
248-5	G	600	0-20	100,000
248-5	G	480	25-60	100,000
248-8	J	600	0-600	200,000
248-10	L	600	601-6000	200,000
248-12	RK1	250 or 600	0-600	200,000
248-12	RK5	250 or 600	0-600	200,000
248-15	T	300	0-1200	200,000
248-15	T	600	0-800	200,000

2.3 FUSEBLOCKS

A. UL 512

B. Thermoplastic base with UL flammability 94VO

C. Clip reinforcing springs – 100A and above

D. 200,000 A RMS Sym withstand rating

E. Copper or aluminum connections

2.4 TOUCH SAFE FUSEHOLDERS

A. UL 512

B. Thermoplastic base with UL flammability 94VO

C. Cover over fuses

D. Neon indicator lamp: "ON" when fuse opens

2.5 SPARE FUSE CABINET

A. Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified with 10% capacity minimum.

B. Doors shall be hinged, with hasp for Owner’s padlock.

C. Finish shall be gray enamel.

D. Cabinet shall have nameplate engraved “Spare Fuses” in 1/2” letters on door.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.2 INSTALLATION

A. Verify proper fuse locations, sizes, and characteristics.

B. Install fuses in fusible devices (specified in 26 2413 – Switchboards, 26 2416.13 - Lighting and Appliance Panelboards, 26 2816 – Enclosed Switches and Circuit Breakers, and 26 2913 – Enclosed Controllers) at job site.

C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.

D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.

E. Install spare fuse cabinet as indicated on drawings.

3.3 APPLICATION

A. Motor Branch Circuits: Class RK5.

B. Other Branch Circuits: Class RK5.

C. Fusible Panelboard Branch Circuits: Class J Cube fuse with indicator.

3.4 CLEANING

A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0573 – Power System Studies

F. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.3 REFERENCE STANDARDS

A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

D. NFPA 70 - National Electrical Code

E. UL 98 - Enclosed and Dead Front Switches

F. UL 486A - 468B - Wire Connectors

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

H. UL 869A - Reference Standard for Service Equipment

1.4 SUBMITTALS

A. Product Data:

1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Test Reports:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations of disconnect switches and ratings of installed fuses.
   b. Record actual locations and continuous current ratings of enclosed circuit breakers.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. Cutler-Hammer

C. Siemens

D. General Electric

2.2 DISCONNECT SWITCHES

A. NEMA KS 1, UL 98

B. Load interrupter enclosed knife switch, heavy-duty type.

C. Fusible or non-fusible type as indicated.

D. Switch Interiors:

1. Switch blades that are visible in "OFF" position when switch door is open.
2. Plated current carrying parts.
3. Removable arc suppressors to permit easy access to line side lugs.

E. Switch Mechanism:

1. Quick-make, quick-break, with visible blades and externally operable handle.
2. Lockable only in “OFF” position and accept three industrial type, heavy-duty padlocks.
3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.
4. Defeater mechanism to bypass interlock.
5. Operating handle integral part of enclosure.
6. Handle to physically indicate "ON" and "OFF" position.

F. Ratings:

1. Ampacity as indicated on drawings.
2. Horsepower rated.

G. Fusible Switches:

1. Rejection clips for Class R fuses specified.
2. Provisions for Class J or Class L fuses, as applicable.
3. Fuses: Per requirements in Section 26 2813 – Fuses.

2.3 ENCLOSED CIRCUIT BREAKERS

A. NEMA AB 1, UL 489.

B. Enclosed molded-case circuit breakers:

1. Tripped indication clearly shown on breaker handle taking position between “ON” and “OFF”.
2. 225A frame size and below: thermal-magnetic trip.
3. 250A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
4. Molded-case switch in lieu of thermal-magnetic molded-case circuit breaker, where indicated.
5. Shunt trip, where indicated.

C. Breaker Mechanism:

1. Quick-make, quick-break.

D. Ratings:

1. Ampacity as indicated on drawings.
2. Listed as Type HACR for air conditioning equipment circuits.
3. Listed as Type SWD for lighting circuits.

2.4 LUGS

A. Front removable lugs.

B. Labeled for 75°C copper and aluminum conductors.

C. Multiple lugs to match number of conductors per phase.

D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.5 ACCESSORIES:

A. Solid neutral assembly, where required.

B. Equipment ground kit.

C. Blown fuse indicators on fused disconnect switches.

D. Factory installed fuse puller on fused disconnect switches.

E. One set of normally open (NO) auxiliary contacts, where disconnect switch is installed at a remote motor served by variable frequency drive (VFD).

2.6 ENCLOSURES

A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.

B. NEMA Type 1, Type 3R (outdoor locations) enclosure.

C. Code-gauge galvanized steel.

D. Manufacturer's standard gray enamel finish over prime coat.

E. Surface-mounted.

2.7 SERVICE ENTRANCE

A. UL 869A

B. Switches and circuit breakers identified for use as service entrance equipment are to be labeled for this application, provided with solid neutral assembly and equipment ground bar, and must include connection for bonding and grounding of neutral conductor.

2.8 SHORT CIRCUIT CURRENT RATING

A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.

B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.

C. Disconnect switches and enclosed circuit breakers mounting:

1. Install disconnect switches and enclosed circuit breakers anchorage devices.
2. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
3. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
4. Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.
5. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.

E. Install top disconnect switch and/or enclosed circuit breaker handle a minimum of 3'-6" and maximum of 6'-6" above finished floor.

F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.

H. Install fuses in fusible switches at job site per requirements in Section 26 2813 – Fuses.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Interpret test results in writing and submit to Engineer.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings per drawings.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262816

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SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes enclosed manual and magnetic motor controllers and enclosed contactors.

B. Motors shown on the drawings or specified in other Divisions of these specifications shall be provided with motorized equipment and connected under this section. Provide motor controllers and power circuit disconnect devices for all motors, unless shown or specified to be furnished with motorized equipment under other Divisions of these specifications, and/or by others, for installation by this contract.

C. Variable-frequency controllers furnished by Division 20 for installation by Division 26.

D. Motor Voltage Information:

1. Voltages available are: 208 and 480 V, 3-phase and 120, 208 and 277V single phase. Circuits are designed for motors with voltage ratings as follows:
   a. Smaller than 1/2 hp motors: 115 V, single phase.
   b. 1/2 hp motors and larger: 200 and 460 V, 3-phase.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

D. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC

E. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks

F. NEMA ICS 5 – Industrial Control and Systems: Control Circuit and Pilot Devices

G. NEMA ICS 6 – Industrial Control and Systems: Enclosures

H. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

I. NEMA MG 1 – Motors and Generators

J. NFPA 70 – National Electrical Code

K. UL 98 – Enclosed and Dead Front Switches

L. UL 486A-486B – Wire Connectors

M. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

N. UL 508 – Industrial Control Equipment

1.4 SUBMITTALS

A. Product Data:

1. Motor controllers: Submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices, dimensions, and enclosure details.
2. Contactors: Submit catalog cut sheets showing voltage, size, current rating, dimensions, and enclosure details.
3. Factory settings and time-current curves of individual protective devices.
4. Confirm motor sizes and voltages with submittals of other Divisions of specifications, and/or by others, prior to Section submittals.

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and/or starting of product.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:

1. Project Record Documents:
   a. Record actual locations and ratings of enclosed motor controllers and enclosed contactors.

2. Operation and Maintenance Data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
   b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain motor controllers, and contactors from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Cutler-Hammer

D. Siemens

E. Allen Bradley

2.2 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for small motors, with melting alloy type overload relay and toggle operator.

2.3 LIGHTING MAGNETIC CONTACTORS

A. Description: NEMA ICS 2, same as magnetic controller, except without overload protection.

B. Poles: To match circuit configuration and control function.

C. Configuration: Mechanically held

D. Contact Rating: Match branch circuit overcurrent protection.

2.4 LUGS

A. Labeled for 75°C copper and aluminum conductors.

B. Multiple lugs to match number of conductors per phase.

C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

D. For equipment specified in this section and for equipment furnished under other Divisions of this specification and/or by others.

2.5 MOTOR CONTROLLERS AND CONTACTOR ENCLOSURES

A. NEMA 250, NEMA 1CS 6.

B. NEMA Type 1, Type 3R (outdoor locations) enclosure.

C. Code-gauge galvanized steel.

D. Manufacturer’s standard gray enamel finish over prime coat.

E. Surface-mounted.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate motor control wiring with Division 23 of these specifications.

B. Coordinate motor sizes and voltages with submittals of other Divisions of these specifications and/or by others.

C. Verify with manufacturer that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive motor controllers and contactors for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for motor controllers and contactors mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data.

3.3 INSTALLATION

A. Install motor controllers and contactors in accordance with ANSI/NECA 1.

B. Install level and plumb, in accordance with manufacturer's written instruction.

C. Motor controllers and contactors mounting:

1. Fasten motor controllers and contractors firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
2. Anchor and fasten motor controllers and contactors and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
3. Install two rows of steel slotted channel, with minimum of four attachment points, for each motor controller and contactor.
4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
5. Do not support motor controllers and contactors only by raceway.

D. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening valves. Where manufacturer's torque valves are not indicated, use those specified in UL 486A-486B.

E. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each motor controller and contactor, using small corrosion resistant metal screws or rivets. Do not use contact adhesive:

1. Indicate motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, and fuse size and type, when applicable.

F. Connect each motor terminal box to rigid conduit system with maximum 18" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

G. Check for proper rotation and phase relationship of each motor.

H. Install fuses in fusible switch at job site pre requirements in Section 26 2813 – Fuses.

I. Control Wiring Installation:

1. Install wiring between motor control devices according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.
2. Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.
3. Bundle, train, and support wiring in enclosures.
4. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   a. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   b. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 APPLICATION

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, and configuration of pilot device and control circuit affecting controller functions.

3.5 CONNECTIONS

A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.

B. Ground and bond motor controller and contactor enclosures according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

C. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.6 FIELD QUALITY CONTROL

A. Inspect motor controllers and contactors for physical damage, proper alignment, connections, anchorage, and grounding.

B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test continuity of each circuit.

D. Interpret test results in writing and submit to Engineer.

3.7 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings as indicated on drawings.

B. Adjust motor circuit protectors.

3.9 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262913

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SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0526 – Grounding and Bonding for Electrical Systems

D. Section 26 3623 – Automatic Transfer Switches

1.2 DESCRIPTION OF SYSTEM

A. Section describes complete package generator set, unit-mounted radiator cooling system, microprocessor based control and monitoring panel, battery and charger, Building Management System (BMS) communications module, remote annunciator, custom weather protective sound attenuated enclosure.

B. Package generator set rated for emergency.

C. Engine fuel system: Sub-base fuel tank

1.3 REFERENCE STANDARDS

A. NEMA MG-1 – Motors and Generators

B. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines

D. NFPA 110 – Standard for Emergency and Standby Power Systems

E. UL 2200 – Stationary Engine Generator Assemblies

F. IEC8528 Part 4 – Control Systems for Generator Sets

G. UL 142 – Steel Aboveground Tanks for Flammable and Combustible Liquids

1.4 SUBMITTALS

A. Shop Drawings

1. Submit for engineering review and approval prior to production release. Include the following for engine-generator:
   a. Outline drawings of equipment showing weights
   b. Overall dimensions including bolting template and earthquake restraints
   c. Right hand, left hand, end, and top views of proposed assembly
   d. Battery, battery rack, battery charger, and wiring diagrams
   e. Vibration isolation bases, mounts, and hangers
   f. Exhaust silencer and flexible fittings
   g. Stub ups for fuel
   h. Power and control wiring entrance locations
   i. Main circuit breaker size, location, and required clearance
   j. Lug sizes and locations
   k. Engine-generator control panel drawings showing devices to be provided, with each device referenced to material list with complete description for device.
   l. Weather protective enclosure installation drawings, structural calculations, lighting fixture catalog cut, conduit, and wiring.
   m. Enclosure sound performance data
   n. Muffler characteristics
   o. Calculations for starting based on step loads outlined in Paragraph 2.2, B.5.
   p. Factory certified prototype test report indicating fuel efficiency and emission levels

2. Information on engine characteristics:
   a. Make, type, and number of cylinders
   b. Brake horsepower (bhp) available
   c. Jacket water heat rejection
   d. Cooling pump characteristics
   e. Exhaust flow rate and temperature at 25, 50, 75, and 100% rated load
   f. Ventilation requirements
   g. Combustion air requirements
   h. Fuel consumption rates at 25, 50, 75, and 100% rated load
   i. Liquid refill capacities
   j. Exhaust backpressure limitation
   k. Type and manufacturer of governor
   l. Alternator size to limit voltage dip to 10%

3. Information on generator characteristics:
   a. Make and type
   b. Type of construction and overspeed capabilities
   c. Temperature rise
   d. Regulation characteristics
   e. Ventilation requirements
   f. Type of winding insulation
   g. KW power factor
   h. Type of exciter and voltage regulator

B. Interconnection detail drawing showing control and power connections in complete standby system. Control connections between components are to be labeled with identical nomenclature. Coordinate with generator manufacturer.

C. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.

D. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

E. Complete test specification detailing testing procedure to be used to verify performance of equipment provided.

F. Recommended spare parts lists.

G. Test Reports:

1. Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.
2. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for each engine-generator.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle equipment in accordance with manufacturer's written instructions. One copy of instructions is to be included with equipment at time of shipment. Maintain factory bracing, packaging, and wrapping.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to Section 01 7700 - Closeout Procedures and herein below.

B. Submit Operation and Maintenance (O&M) manuals to Engineer for review 60 days prior to acceptance of unit.

C. Installation, maintenance, and operating instruction manuals shall include, but not limited to, the following:

1. 100% accurate system "as-installed" drawings, interconnect diagrams, schematic diagrams, wiring diagrams, individual sub-system component manuals, operation procedures, system description with theory of operation, maintenance schedules and procedures, original programmed settings and parameters, and other information necessary for the Owner to maintain, operate, test, and troubleshoot system.
2. The O&M manual shall contain step-by-step instructions for startup and shutdown. The first page shall contain name, address, and phone number of local representative to be called for service or parts. Follow with complete parts lists by actual ordering catalog numbers. O&M manual also shall contain four copies each of test record forms and service record forms for Owner use. Forms shall show proper interval for testing, servicing, and replacing of components, lubrication, filters, antifreeze, etc., including recommended specifications and fluid levels for lubricants.
3. Recommended spare parts list (with pricing) for 2 yrs of operation.

D. O&M manuals shall not solely rely on sub-component manuals. Thorough consolidation of operating and maintenance information shall be available in system overview guide. Include major components of system in overview.

E. Turn final reviewed manuals over to Owner prior to conducting training of Owner personnel.

F. Seal single copy of service record forms, recommended operation and service practices for unit in plastic and wall mount in weather-protective enclosure.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:

1. Engine Generator Set - Caterpillar, Cummins, MTU Onsite Energy, Kohler
2. Exhaust Silencer – Maxim, Nelson, or approved equal
3. Isolation equipment
4. Battery charger – Sens, La Marche, Charles Industries

2.2 RATINGS AND PERFORMANCE

A. Engine Generator Set

1. Generator kW Output: As shown on drawings
2. Altitude 300 ft above sea level in ambient temperature of 104°F**.**
3. Stable frequency regulation

B. Alternator

1. SKVA as shown on drawings, .8 Power Factor
2. 480 V, 3 Ph, 60 Hz, 4 Wire Y
3. Stable voltage regulation 0-full load less than or equal to ± .5%.

C. Transient Performance

1. Engine
   a. Start and load in 10 seconds per NFPA 110
   b. Accept 100% block load per NFPA 110

2. Frequency regulation ± .25% no load to full load. ± .25% steady state.
3. Alternator
   a. 15% Voltage dip
   b. AC waveform output contains <5% total harmonic distortion (THD) at full linear load when measured from line to neutral with <3% in any single harmonic, and no third-order harmonics or their multiples.
   c. Telephone influence factor < 40
   d. Telephone harmonic factor < 3

D. Factory Prototype Test Certified

1. Harmonic Distortion Levels
   a. Demonstrate

2. Airflow Restriction tests
   a. Demonstrate controlled shutdown after overheating

3. Unit tested with enclosure
   a. UL 2200 listed

4. 30 Degree Water Spray Unit Rain Test
   a. Demonstrate no water leakage into electrical boxes

5. Overload Test
   a. Demonstrate 10% overload with no damage to engine

6. Air Filter Test
   a. Demonstrate engine contains engine backfire explosion

E. Factory Production Test Certified

1. Alternator Impedance to Ground
2. Dielectric Testing
   a. At 1000 V and 2 times rated voltage

3. Maximum kW Rating
4. Engine Response Time
5. Alternator Construction Testing
   a. Impedance Balance Tested

6. Alternator Insulation Testing
   a. Surge Tested

2.3 FABRICATION AND MANUFACTURER

A. Engine:

1. Type: Inline or vee
2. Four-stroke cycle diesel compression ignition at 1800 RPM consistent with engine durability.
3. Aspiration: Turbo Charged After Cooled
4. Horsepower
   a. Brake Horsepower 640

5. Water cooled
6. Fuel Type: No. 2 domestic diesel fuel oil.
7. Engine accessories:
   a. Fuel filter
   b. Lube oil filter
   c. Intake air filter
   d. Lube oil cooler
      1) Suitable for operation of generator set at full rated load in ambient temperature specified.
   e. Fuel transfer pump
   f. Fuel priming pump
      1) Engine driven positive displacement, mechanical, full pressure
   g. Gear driven water pump
   h. Electronic direct fuel injection or have suitable emission control equipment
   i. Electric speed sensing governor capable of isochronous regulation.

j. Safety-shut-offs for:
   1) High water temperature
   2) Low oil pressure
   3) Overspeed
   4) Overcranking

8. EPA Certified Tier 2

B. Cooling System:

1. Engine skid mounted, engine-driven radiator with blower type fan, sized to maintain safe operation at 122°F ambient temperature.
2. Arrange liquid-cooled prime movers for NFPA level 1 applications for closed-loop cooling.
3. Provide radiator with:
   a. Motor-driven fan with voltage same as generator
   b. Motor Starter
   c. Initiating contacts to actuate on generator startup
   d. Connect to generator distribution system
   e. Core guard
   f. Fan guard
   g. Mounting hardware
   h. Direct adapter flange. Ductwork with flexible connection between radiator and exhaust plenum to be provided by Division 23. Coordinate with Division 23.
   i. Flexible pipe connections at engine and radiator.
   j. Supply power for fans and pumps on remote radiators from a tap at generator output terminals or ahead of first load circuit overcurrent protective device.
   k. Heat exchangers

4. Block Heater
   a. Water Jacket Heater: Circulating
   b. Maintain engine jacket water to 110°F in ambient temperature of 30°F
   c. Heater to be equipped with thermostatic switch.
   d. Single phase 208 V

5. Fill engine cooling system with solution of 50/50 mix ethylene glycol at initial fill.
6. Ductwork with flexible connection between radiator and exhaust dampers to be provided by others. Refer to Section 23 3113 – Facility Fuel Oil Piping.

C. Exhaust System:

1. Furnish critical type exhaust silencer:
   a. Sized according to manufacturer's recommendations
   b. Mount so weight is not supported by engine
   c. Flexible exhaust fitting
   d. Installation inside drop over enclosure

2. Condensate Traps
   a. Drain plug at low point of muffler

3. Thermal Expansion
   a. Stainless steel exhaust flex to accommodate thermal growth and vibration isolation

4. Exhaust Blankets

a. 1” high temperature fiberglass cloth wrap
b. Coordinate with weather protective enclosure.

5. Thimble
   a. Pipe and wall of compatible construction

6. Acceptable Back Pressure
   a. Size silencer and exhaust pipe so exhaust back pressure does not exceed maximum limitations specified by generator set manufacturer.

7. Exhaust clearing area

D. Starting System

1. Provide DC electric starting system with positive engagement drive. Provide DC voltage recommended by manufacturer.
2. Provide fully automatic start-stop controls.
3. Provide cycle cranking to open and lock out start circuit after 3 attempts to start failed engine start.
4. Batteries
   a. Provide sealed lead-acid storage battery set:
      1) Heavy duty diesel starting type
      2) Voltage compatible with starting system voltage
      3) Capacity to provide for 1-1/2 minutes total cranking time at 0°F without recharging. In accordance with NFPA Level 1.
   b. Provide vinyl coated steel battery rack.
   c. Provide starting battery heater:
      1) Heater plate under battery
      2) Heater type blanket around battery case
      3) Thermal switch - heater control relay
      4) 120 VAC input
   d. Battery cables and clamps

5. Battery Charger
   a. Four Rate Battery Charger
      1) Constant current, constant voltage, high rate taper, and float equalized.
   b. Dual Rate Battery Charger
      1) Constant current, and float equalized
   c. Charger Accessories:
      1) Overload protection
      2) ±0.5% line and load regulation
      3) Electronic current limit output 105%
      4) DC ammeter and voltmeter.
      5) UL 1236 listed and meets NFPA 110 requirements
      6) Output protection
      7) Temperature compensation
      8) Enclosed in NEMA 1 aluminum or stainless steel enclosure
      9) Form C contacts for the following alarms
         a) AC fail
         b) Low battery volts
         c) High battery volts
         d) Charger fail
         e) Battery fault

6. AC input voltage: 208 V
7. When installed on the engine generator set, mount on vibration isolators.

E. Speed Control

1. Electronic: Isochronous

F. Alternator:

1. Maximum temperature rise 135°C at 40°C ambient
2. Synchronous type
3. Self ventilated
4. Drip-proof construction
5. Directly connected to engine flywheel housing with a flex coupling
6. Capable of sustaining 300% overcurrent for 10 seconds under a 3 Ph symmetrical short circuit
7. 120 V Anti-Condensation heater
8. Subtransient Reactance limited to 12%
9. Insulation
   a. Complies with NEMA (MG1-33.4)
   b. Class H Insulation Systems
      1) UL 1449 recognized
      2) Vacuum impregnated with epoxy varnish
      3) Fungus resistant

10. Permanent magnet brushless excitation (PMG)
    a. PMG shall derive excitation current from pilot exciter mounted on the rotor shaft. It is to be able to sustain 300% of rated current for ten seconds during a fault condition.
    b. Self-excited system to be brushless and consist of a 3 Ph armature and a 3 Ph full wave bridge rectifier mounted on the rotor shaft. Include surge suppressors to protect the diodes from voltage spikes.

11. Rotor
    a. 4 pole
    b. Winding
       1) Wet layer wound
    c. Varnish process
       1) Epoxy based material applied to each layer of magnet wire
    d. Coil supports
       1) Driven through flexible coupling to ensure permanent alignment.
    e. End winding spacing
    f. Amortisseur windings
    g. Bearings
       1) Sealed
       2) Single

12. Stator
    a. 3 Ph winding
    b. Laminations
    c. Cooling air passages and fan
       1) Provide space heater to keep alternator free of moisture. Space heater to be 1500 W, 120 VAC, 1 Ph.
    d. Welded laminations to prevent cutting of wires

e. Skewed stack to minimize slot ripple on output voltage and produce smooth voltage waveform.
f. Pitch – Skewed design to optimize efficiency and minimize total harmonic distortion.
g. Varnish process
   1) 2 dips and bakes using Class A impregnating varnish

13. Alternator Components
   a. Solid state design digital voltage regulator:
      1) Performance
         a) Microprocessor based.
         b) Programmable
         c) Regulation: ± .25% at any constant load for any load from 0% to 100% of pf rating.
         d) 3 Ph, true RMS sensing
         e) PMG input, engine unloading
         f) Design insensitive to severe, load induced wave shape distortion from SCR or thyrister circuits such as those used in battery charging, UPS, and motor speed control equipment loads.
         g) Controls to limit build-up of AC generator voltage to provide a linear rise and limit overshoot.
         h) Digital adjustments for out voltage adjustment gain, damping and frequency rate–off.
         i) System setup controls and fault alarms.
      2) Protection
         a) Over-excitation protection
         b) Electronic voltage buildup protection
         c) Loss of sensing protection
         d) Temperature compensation
         e) Limitation of voltage overshoot on startup
      3) Features
         a) Parallel support
         b) VAR/PF control
      4) Environmentally sealed
      5) UL 508A listing
   b. Output Circuit Breaker(s)
      1) 100% thermal magnetic rated circuit breaker, size and quantity as indicate on drawings
      2) Adjustable long time, long time delay, short time, and short time delay curve shaping elements
      3) Shunt Trip for integration with load bank controls
      4) Solid state trip fixed mounted generator mounted circuit breaker
      5) NEC required access in front of breaker
      6) Ground fault alarm only: Monitoring relay for breaker 1000A and above. Relay to be adjustable from 3.8 – 1200A and include an adjustable time delay of 0-10S.

G. Controls:

1. NFPA 110 listed
2. Micro-processor based solid state controls to automatically start, protect and monitor engine-generator set with panel illuminating lighting and digital display.
3. Control panel includes:
   a. Solid state trip main circuit breaker

b. Motor starting switch
c. Electrically operated fuel control
d. Relay to disconnect battery charger during cranking
e. Switching lamps and meters to be oil tight and dust tight. All active components to be installed within a NEMA 1 enclosure. There shall be no exposed components with door open operating 750 V.
f. Protective relays to open main circuit breaker**(s)** and shut down and lockout engine on abnormal conditions including:
   1) Overspeed
   2) Operation of Remote Stop
   3) Overcrank
   4) Low lube oil pressure
   5) High Engine Temp
g. Monitoring items shall include but is not limited to the following items and control:
   1) Coolant temperature
   2) Oil pressure
   3) Battery voltage
   4) RPM
   5) Voltmeter, 3-1/2” dual type, 0.5% accuracy with selector switch
   6) Ammeter, 3-1/2” dual type, .05% accuracy with selector switch
   7) Frequency meter, 55-65 Hz ±0.125 Hz.
   8) Running Time Meter (hours and 1/10 hours)
   9) AC power metering to be 0.5% accuracy and include frequency, phase, selector switch with real time power metering including, kW, kVA, kVAR, kWh, PF, % of rated load.
h. Control Items:
   1) Voltage level adjustment rheostat
   2) Overspeed level adjustment
   3) Overvoltage level adjustment
   4) Undervoltage level adjustment
   5) Overfrequency level adjustment
   6) Underfrequency level adjustment
   7) Position function switch(es) marked AUTO, MANUAL RUN, OFF/RESET and STOP
   8) 4 NO and 4 NC dry contacts for local and remote alarms, wired to terminal strips.
   9) Emergency off mushroom button
   10) Automatic remote start capability. Engine cranking system to permit minimum 4 cranking attempts of 10 seconds (adjustable) duration with rest of periods of 10 seconds (adjustable).
      a) Overcrack lockout shall occur after 4 cranking attempts.
i. In accordance with NFPA 110, Level 1, control panel shall furnish battery-powered individual visual alarm indicator functions at battery voltage and visual and audible pre-alarm:
   1) Overcrank
   2) Low water temperature
   3) High engine temperature pre-alarm
   4) High engine temperature
   5) Low lube oil pressure pre-alarm
   6) Low lube oil pressure
   7) Overspeed
   8) Low fuel main tank
   9) Low coolant level

10) EPS supplying load
11) Control switch not in automatic position
12) High battery voltage
13) Low cranking voltage
14) Low voltage in battery
15) Battery charger ac failure
16) Lamp test
17) Contacts for local and remote common alarm
18) Low starting air pressure
19) Low starting hydraulic pressure

j. Engine shut down, with audible alarm:
1) Low oil pressure
2) High engine temperature
3) Overcrank
4) Overspeed
5) Remote Emergency Stop
6) Overcurrent (circuit breaker trap and lockout)
7) Low-coolant level

k. Status report:
1) Engine running
2) Circuit breaker open
3) Circuit breaker closed

4. Visual alarm resettable only after fault condition has been corrected.
5. Audible alarm shall include silencing circuit, which, after activation, will permit annunciation of subsequent failures.
6. Control Panel mounting:
a. Mounted on engine generator set in NEMA 1 enclosure on shock isolators
b. Wall mounted in NEMA 1 enclosure
c. Free standing in NEMA 1 enclosure

7. Provide remote annunciator panel
a. Compliant with NFPA Level 1 requirements.

H. Isolate engine generator set from building structure and from connecting services.

1. Separately derived grounding system. Connect generator ground as shown on drawings to grounding electrode system.

I. Termination Bars and Connections:

1. Silver- or tin-plated copper bus bars for terminating cables.
2. Standard NEMA standard bolt hole spacing, for 3 Ph and neutral, within generator connection box with gasketed bolt on cover.
3. Engine-generator set control interfaces to other system components to be made on a permanently labeled terminal block assembly. Provide labels describing connection points.
4. Connections to engine-generator set: Flexible or isolation type connections. Include electrical, fuel, exhaust, and ventilation connections.

J. Equipment Bases:

1. Mount complete unit on a structural steel sub-base, rectangular in shape, with sufficient rigidity to maintain alignment of generator set. Provide perimeter beams with minimum

depth equal to 1/10 of longest dimension of base, except beam depth need not exceed 14" provided that deflection and misalignment are kept within acceptable limits as determined by manufacturer. Engine-generator set to be statically and dynamically balanced at factory. Peak-to-peak amplitude of vibration velocity in horizontal, vertical, and axial direction shall not exceed 0.65" per second at main structural components.

2. Engine-generator set weight distribution is to be considered to provide uniform deflections.
3. Bases shall provide equipment alignment and assure uniform weight distribution. Provide side brackets on bases to contain isolating mounts and reduce total installed heights of equipment.

K. Vibration Isolators:

1. Prevent equipment vibrations from being transmitted to enclosure.
2. Required between the structural steel sub-base and concrete housekeeping pad.
3. Steel or cast iron top and bottom housings incorporating 1 or more steel springs with built-in leveling bolts and built-in resilient chocks to control oscillation and withstand lateral forces in all directions.

L. Custom Weather Protective Sound-Attenuated Enclosure

1. Include sub-base tank as described in this specification.
2. NEMA 3R rated
   a. Sound attenuated enclosure to reduce sound level of engine generator set while operating at full rated load and ventilation to a maximum of 60 dbA at property line from engine generator in free-field environment.

3. Overall Size:
   a. Drawings show generator footprint, which is maximum allowed for available space.
   b. Air intake limitations as shown on drawings. System operating within space limitations indicated above.

4. Construction:
   a. Welded, 12 ga galvanized steel to ASTM A-446.
   b. Walls: 3" thick satin coat steel formed panels with wall studs 16" on center designed to withstand wind loads as required by UBC.
   c. Roof: 3" thick with 3" deep cross members every 24" minimum, seal welded construction, and crowned to prevent ponding of water.
   d. Interior insulation: 3" thick rigid fiberglass. Insulation lined with 22 ga perforated steel screwed in place. Intake and discharge to be lined with poly prior to lining with 22 ga perforated steel.
   e. Interior liner: 22 ga perforated galvanized steel.
   f. Base: Nominal 3" x 2" perimeter mounting angle with 7/8" diameter anchor holes and suited for seismic hold down.
   g. Access doors: Minimum two 18 ga galvanized steel doors, each 36" x 80", complete with panic hardware with exterior thumb latch, ball bearing hinges, weather stripping, stainless steel threshold, and drip edge.
   h. Lifting lugs

5. Ventilation:
   a. Turn-down Intake: complete with motorized-type damper, hood with silencer, flex connections, and 1/2" x 1/2", 16 ga galvanized bird screen.
   b. Turn-up Discharge: complete with gravity-type damper with discharge duct, hood with silencer, flex connector, and 1/2" x 1/2", 16 ga galvanized bird screen.

6. Electrical:
   a. Include panelboard wired to the following:
      1) 4 battery-powered LED fixtures, lamps, battery and wire guard; battery units shall have a minimum run-time of 90 minutes.
      2) (2) 3-way switches
      3) 2 GFCI duplex receptacles
      4) 2 block heaters wired to a junction box local to front of generator set
      5) Battery charger
      6) Battery heater
      7) Space heater
      8) 120 V circuit for day tank reverse pump
      9) 120 V circuit for day tank controls
   b. Wiring shall be #12 AWG minimum in surface-mounted EMT conduit with compression fittings.
   c. Coordinate all loads type, voltage, and rating with engine-generator supplier prior to ordering panel. See panel schedules for connection of loads.
   d. Provide with 36” space in front of panelboard with doors open.
   e. Provide electrical connections from bottom of enclosure. Water seal around enclosure floor penetrations.

7. Paint:
   a. Clean surfaces to SSPC-SP1, seams sealed, primed with industrial phenolic primer to 1.5 mils D.F.T. Top coat exterior with Clovacoat epoxy enamel to 2.0 mils D.F.T.
   b. Coordinate color with Architect.

M. Fuel System

1. Sub-base Fuel Tank and Appurtenances
   a. Capacity: 3,000 gal minimum, Class 72
   b. Rating: UL 142 Listed
   c. Double Wall Construction
   d. Flex fuel lines (NFPA 110 construction)
   e. Epoxy lined to prevent corrosion
   f. Tank Exterior: Chemically treated, primed, and painted in factory standard.
   g. Tank Accessories
      1) Overfill prevention valve on tank fill inlet
      2) Visual dial type fuel level gauge
      3) Manual gauge port with stick gauge
      4) Fuel supply and return ports
      5) Atmospheric vent port and mushroom type UL-listed flame arrester vent to be installed onto vent pipe by others
      6) Containment tank emergency vent port and pressure relief cap.
      7) Primary tank emergency vent port and pressure relief cap.
      8) Digital tank monitor/overfill control panel with pilot warning lights, audible alarm, output contactors, and press to silence/test/reset feature equal to Pneumercator TMS 2000. Provide with analog output option for use by Building Automation System. (Mounted near tank indoors.)
      9) Overfill panel with pilot warning light, audible alarm and press to silence/test/reset feature (mounted near tank indoors). Panel shall interface to digital tank monitor.
      10) Fill spill box
      11) Leak detection
      12) Required internal piping and wiring

13) Decals and signs required by code and authority having jurisdiction.

h. UL 142 prototype test requirements:

1) Submit certified prototype test report that includes the following tests:

a) Fire Tests. In full-scale fire test, tank is placed in furnace where temperature is quickly raised to 2000°F to simulate fire of pooled fuel beneath tank. During test, maximum temperature inside tank must not exceed 260°F above ambient temperature (for example, if ambient temperature is 60°F, tank's internal temperature must not exceed 320°F). At no time may tank's internal temperature exceed 400°F. Immediately following fire test, tank is subjected to hose stream test, then tested for leakage.

2. System shall comply with local codes and permitting requirements.

2.4 LOAD PRIORITIES

A. The following load priorities shall be provided:

1. Priority #1 – Emergency Systems
2. Priority #2 – Optional Standby Systems

2.5 PRIORITY ~~LOAD ADDING AND~~ LOAD SHEDDING

A. Loa~~d adding and load~~**d** shedding:

~~1. Priority load adding and load shedding are to be provided by automatic opening and closing distribution circuit breakers in standby switchgear.~~
~~2. Upon signal from ATS to start engine, feeder circuit breakers for Priority #1 loads shall remain closed, but automatic transfer switch for Priority #2 loads are to be opened.~~
~~3. Provide opening of feeder circuit breakers within no more than 6 seconds and before automatic transfer switch will be connected to engine-generator.~~
~~4. Load adding to be done on load priority basis. Next priority loads to be added based on ascending sequential priority.~~
~~5. Load adding of priority loads to be achieved by closing feeder circuit breakers for corresponding priorities.~~
~~6. Load shedding shall be done on a last-on, first-off basis.~~
1. L**oad shedding to occur when generator exceeds 100% load for 5 seconds.**
~~7.~~ **L**oad shedding **t**~~of priority loads t~~o be achieved by **switching**~~opening~~ standby **ATS to normal power position**~~switchgear feeder circuit breakers for corresponding priorities,~~ upon signal from **generator load shed relay.**~~Building Control System (BCS) to standby switchgear.~~
~~8.~~**2.** ~~Load shedding is not performed for priority #1 loads.~~

2.6 INTERFACE WITH BUILDING MANAGEMENT SYSTEM (BMS)

A. Interface shall be as follows:

1. Control panel shall incorporate communication module with digital communication port connection to building control system (BMS) via **BACNET IP** Ethernet communication.
2. Communications shall be for the following:

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
LD~~I~~**I - LAN** 1	~~Low lube oil pressure prealarm~~**General alarm**	
LD~~I~~**I - LAN** 2	Low ~~water temperature~~**fuel**	
L**A**~~D~~**I I - LAN 1**~~3~~	~~High engine temperature prealarm~~**Fuel usage**	
~~LDI 4~~	~~Battery charger AC failure~~	
~~LDI 5~~	~~Spare~~	
~~LDI 6~~	~~Control switch not in automatic position~~	
~~LDI 7~~	~~High battery voltage~~	
~~LDI 8~~	~~Low coolant level~~	
~~LDI 9~~	~~Low cranking voltage~~	
~~LDI 10~~	~~Low voltage in battery~~	
~~LDI 11~~	~~EPS supplying loads~~	
~~LDI 12~~	~~Generator circuit breaker ground fault~~	
~~LDI 13~~	~~Low lube oil pressure~~	
~~LDI 14~~	~~High engine temperature~~	
~~LDI 15~~	~~Overcrank~~	
~~LDI 16~~	~~Overspeed~~	
~~LDI 17~~	~~Remote emergency manual stop switch~~	
~~LDI 18~~	~~Overcurrent (circuit breaker trip and lockout)~~	
~~LDI 19~~	~~Reverse power relay trip~~	
~~LDI 20~~	~~**[Failure to synchronize]**~~	
~~LDI 21~~	~~Engine running~~	
~~LDI 22~~	~~Generator running~~	
~~LDI 23~~	~~Generator circuit breaker open~~	
~~LDI 24~~	~~Generator circuit breaker closed~~	
~~LDI 25~~	~~Generator circuit breaker failed to close~~	
~~LDI 26~~	~~Spare~~	
~~LDI 27~~	~~Control voltage failure~~	
~~LDI 28~~	~~Auto start~~	
~~LDI 29~~	~~Battery charger failure~~	
~~LDI 30~~	~~Spare~~	
~~LDI 31~~	~~Spare~~	
~~LDI 32~~	~~Spare~~	
~~LDI 33~~	~~Sub-base fuel storage leak~~	
~~LDI 34~~	~~Spare~~	
~~LDI 35~~	~~Spare~~	
~~LDI 36~~	~~Spare~~	
~~LDI 37~~	~~Spare~~	

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
~~LDI 38~~	~~Spare~~	
~~LDI 39~~	~~Spare~~	
~~LDI 40~~	~~Spare~~	
~~LDI 41~~	~~Spare~~	
~~LDI 42~~	~~Load shed activated Priority #2~~	
~~LDI 43~~	~~Load shed activated Priority #3~~	
~~LDI 44~~	~~Load shed activated Priority #4~~	
~~LDI 45~~	~~Load shed activated Priority #5~~	
~~LDI 46~~	~~Load shed activated Priority #6 (spare)~~	
~~LDI 47~~	~~Load shed activated Priority #7 (spare)~~	
~~LDI 48~~	~~Load shed activated Priority #8 (spare)~~	
~~LDI 49~~	~~Load demand activated Priority #2~~	
~~LDI 50~~	~~Load demand activated Priority #3~~	
~~LDI 51~~	~~Load demand activated Priority #4~~	
~~LDI 52~~	~~Load demand activated Priority #5~~	
~~LDI 53~~	~~Load demand activated Priority #6 (spare)~~	
~~LDI 54~~	~~Load demand activated Priority #7 (spare)~~	
~~LDI 55~~	~~Load demand activated Priority #8 (spare)~~	
~~LDI 56~~	~~Air damper closed~~	
~~LDI 57~~	~~System test mode (lamp test)~~	
~~LDI 58~~	~~Spare~~	
~~LDI 59~~	~~Spare~~	
~~LDI 60~~	~~Spare~~	
~~LDI 61~~	~~Spare~~	
~~LAI 1~~	~~Generator phase A-B voltage~~	~~Volts~~
~~LAI 2~~	~~Generator phase B-C voltage~~	~~Volts~~
~~LAI 3~~	~~Generator phase C-A voltage~~	~~Volts~~
~~LAI 4~~	~~Generator phase A current~~	~~Amperes~~
~~LAI 5~~	~~Generator phase B current~~	~~Amperes~~
~~LAI 6~~	~~Generator phase C current~~	~~Amperes~~
~~LAI 7~~	~~Total real power~~	~~KW~~
~~LAI 8~~	~~Total apparent power~~	~~KVA~~
~~LAI 9~~	~~Total reactive power~~	~~KVAR~~
~~LAI 10~~	~~Generator power factor~~	
~~LAI 11~~	~~Generator phase A frequency~~	~~Hertz~~
~~LAI 12~~	~~Generator phase B frequency~~	~~Hertz~~
~~LAI 13~~	~~Generator phase C frequency~~	~~Hertz~~
~~LAI 14~~	~~Battery voltage~~	~~Volts~~
~~LAI 15~~	~~Engine oil pressure~~	~~KPA~~
~~LAI 16~~	~~Engine speed~~	~~RPM~~

TYPE	CONDITION/DESCRIPTION	RANGE/UNITS
~~LAI 17~~	~~Engine water temperature~~	~~Degrees Centigrade~~
~~LAI 18~~	~~Engine running time~~	~~Hours~~
~~LAI 19~~	~~Spare~~	
~~LAI 20~~	~~Spare~~	
~~LAI 21~~	~~Spare~~	
~~LDO 1~~	~~Remote fault reset~~	
~~LDO 2~~	~~Remote start initiative~~	
~~LDO 3~~	~~Cool down override control~~	
~~LDO 4~~	~~Phase select~~	
~~LDO 5~~	~~Load adding and load shedding~~	

Notes:

LDI - LAN: Digital Input from control panel communication module to BMS via Ethernet communication.

LAI - LAN: Analog Input from control panel communication module to BMS via Ethernet communication.

LDO - LAN: Digital Output from BMS to communication module via Ethernet communication.

LAN – Local Area Network

3. Provide all additional information as required for a complete and operable system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engine-generator set and associated equipment as indicated. Coordinate final location of equipment with General Contractor. Final location of equipment to be reviewed with Engineer prior to installation.

B. Install equipment in accordance with manufacturer's recommendations. Provide equipment protection during and subsequent to installation.

3.2 LOAD TEST

A. Conduct load testing of engine-generator set, under direct supervision of factory-authorized representatives of manufacturers of engine-generator set and auto-transfer switch.

1. Coordinate manufacturer representative to connect to generator controller to record trend data. Include trend data and files in certified report.

B. Provide external load bank control power for the load bank to avoid control drop-out during 100% block load.

C. Installation is NFPA 110, Level 1 – Authority Having Jurisdiction must be given notice prior to testing as required in NFPA 110.

D. Testing to include cold start, 25, 50, 75, and 100% step loads (slow addition of load to confirm operation), 50% and 100% block loads (instantaneous load percentages), and 8 hour testing at rated nameplate.

   1. Loading shall be by use of contractor rented portable load banks.

E. Provide certified results of testing, including frequency and voltage regulation at 25, 50, 75, and 100% of rated load, fuel consumption, exhaust temperature, and exhaust emissions at the above load ratings, actual measured values for pickup and drop out relays for ATS, measured values for time delay relays.

F. Engine-generator set test results are to be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified at no additional cost to owner.

G. At conclusion of testing, service engine-generator set including replacing air, oil and fuel filters, changing lubrication oil, checking and refilling batteries, adjusting fan belts for proper tightness, and refilling of cooling system as required.

H. Provide fuel for load testing of engine-generator set.

END OF SECTION 263213

SECTION 263623 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0529 – Hangers and Supports for Electrical Systems

C. Section 26 3213 – Engine Generators

1.2 DESCRIPTION OF SYSTEM

A. Provide automatic transfer switch, 3 phase, 60 Hz, 3 pole, with solid neutral for voltage and current as indicated on drawings.

1.3 REFERENCE STANDARDS

A. ICS 10 Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment

B. UL1008 Automatic Transfer Switches

1.4 SUBMITTALS

A. Submit shop Drawings for equipment provided under this Section.

1.5 QUALITY ASSURANCE

A. Obtain automatic transfer switches from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

C. Factory Test

1. Provide factory test report.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchgear as required to prevent condensation.

B. Deliver in shipping splits of length that can be moved in delivery path, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Use factory-installed lifting provisions. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.7 WARRANTY

A. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers: Asco, Cummins, Russelectric, or Zenith

2.2 AUTO-TRANSFER SWITCH

A. Auto-transfer switch:

1. Mechanically held, electrically operated type
2. Interlocked to ensure only 2 possible positions, normal and emergency.
3. Rated for continuous duty in unventilated sheet metal enclosure
4. Suitable for all classes of loads at maximum rated voltages
5. Withstand rating that meets or exceeds withstand rating of transfer switch feeder breakers.
6. Shall be open transition type.

B. Provide main contacts with silver alloy wiping action type protected by arcing contacts.

C. Provide switch components accessible from front of enclosure.

D. Provide 3 cycle short circuit rating to guarantee contact opening and no damage when transfer switch is served by molded case circuit breakers.

E. Provide switch with the following items:

1. Adjustable 1 to 3 second time delay to override momentary voltage dips and outages.
2. Time delay on transfer to emergency. Adjustable from 1 to 300 seconds (factory set at 3 seconds).
3. Time delay on retransfer to normal. Adjustable from 2 seconds to 30 minutes.

4. Full phase protection consisting of 2 phase relays and one close differential relay. Phase relays shall be set to 70% drop out, 90% pick up, and differential relays set for 92 to 95% pick-up and 83 to 85% drop-out.
5. Pushbutton reset to normal.
6. Pushbutton to bypass time delay on retransfer to normal.
7. Pilot light to indicate normal position.
8. Pilot light to indicate emergency position.
9. Auxiliary contact to close when normal power fails.
10. Auxiliary contact to open when normal power fails.
11. Auxiliary contact on same shaft as main contacts (closed on normal).
12. Auxiliary contact on same shaft as main contacts (closed on emergency).
13. Four position selector switch to provide "Test," "Auto," "OFF", and "Engine Start."
14. Contacts to start engine-generator when normal power fails.
15. Time delay engine start, adjustable from 0 to 5 seconds.
16. Adjustable time delay on retransfer to normal source with 5 minute unloaded running time of standby plant:
    a. Minimum delay 2 minutes
    b. Maximum delay 25 minutes
    c. Built in circuitry to nullify time delay if emergency source fails and power is available at normal source.

17. Relay to prevent transfer to emergency until voltage and frequency of generating plant have reached 90% of rated value.
18. Provide bi-direction in-phase monitor or dual motor operator with programmed neutral to allow voltage decay in motor and transformer circuits.

F. Provide BACnet IP **ethernet** communications functionality to BAS for the following ATS status:

1. ATS **position change** ~~in~~ Normal ~~position~~**to Emergency**
2. ATS **position change Emergency to Normal**~~in Emergency position~~
3. **ATS test switch operated**
~~2.~~**4. ATS general alarm**

G. Provide functionality for load shed function for transfer switch ATS-S.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. Provide equipment protection during and subsequent to installation.

C. Provide wiring between transfer switch and elevator controller. Final connections at elevator controller by Elevator Contractor.

D. Connect transfer switches that are part of fire pump controllers.

3.2 OPERATION

A. Parallel "start engine-generator" contacts of automatic transfer switches, such that failure of normal source at any switch shall start engine.

B. Transfer of one switch from normal to emergency shall not preclude any other switch from transferring.

C. Engine generator cool down cycle shall not start until all transfer switches have timed out back to normal source.

END OF SECTION 263623

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 – Grounding and Bonding for Electrical Systems

B. Section 26 0533 – Raceway and Boxes for Electrical Systems

1.2 DESCRIPTION

A. Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

1.3 REFERENCE STANDARDS

A. ANSI/NEMA GR1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings

B. NFPA 70 - National Electrical Code

C. NFPA 780 - Standard for the Installation of Lightning Protection Systems

D. UL 467 – Grounding and Bonding Equipment

E. UL 96 - Lightning Protection Components

F. UL 96A - Installation Requirements for Lightning Protection Systems

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer's descriptive and technical literature and catalog cuts.

B. Shop Drawings:

1. Submit installation shop drawings for the overall lightning protection system. Include physical layout of the equipment, mounting details, and relationship to other parts of the work.
2. Submit detail drawings for each major component.
3. Submit location, size, and material of grounding electrodes, and connection type.
4. Submit roof adhesive data for air terminals mounted on single-ply roofing.

C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply roofing material.

D. Copy of Owner's UL Master Label Certificate.

E. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

F. Closeout Submittals:

1. Project record documents:
   a. Record active location of lighting protection system components.

2. Operation and maintenance data:
   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Lightning protection system materials:
   a. Consists of standard products by a manufacturer regularly engaged in production of lightning protection systems.
   b. UL Listed

2. Lightning protection system installer: UL Listed.

B. Regulatory Requirements:

1. Lightning protection system: Comply with NFPA 780, UL 96, and UL 96A.

C. Certifications:

1. Furnish Owner with UL Master Label Certificate upon completion of installation providing proof that the lightning protection system is in compliance with UL 96 and UL 96A standards.

1.6 SEQUENCING

A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thompson Lightning Protection Company

B. Harger Lightning Protection, Inc.

C. Heary Brothers Lightning Protection Company, Inc.

D. National Lightning Protection Corporation

E. Erico International Corporation

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. NFPA 780, UL 96.

B. Materials: Air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, air terminal supports, chimney bands, clips, and connections: Class I:

1. Air terminals: Solid type with a safety tip, 10” in height minimum, above the object to be protected when spaced at intervals not exceeding 20 ft, with mounting base.

C. ANSI/NEMA GR1 Grounding Electrodes: 3/4” x 10 ft long copper-clad steel ground rod.

D. Concrete-Encased Electrodes: As shown on drawings.

E. Solid Copper Ground Plate (if called for on drawings): Where shallow or rocky top soil conditions preclude the use of driven ground rods. This ground plate is 18” x 18” x 20 gauge thick (0.032” minimum) and comes complete with two premium die cast bolt pressure type cable connections for cables through #3/0.

F. Ground Ring Electrode: As shown on drawings.

G. Ground Connectors: Conform to UL 96

1. Bronze of the clamp type and bronze clamp accessories.
2. Provide in accordance with the requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

H. Materials:

1. Aluminium materials over 18” above earth except where the use of copper materials is necessary for galvanic compatibility.
2. Copper materials below grade and up to 18” above earth.
3. Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
4. Bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lighting protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.

B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.

C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.

D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.

E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, where necessary, to prevent physical damage or displacement to the conductor. Use PVC Schedule 40 conduits. Provide conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

   1. Provide down conductors for every 100 feet of building perimeter.
   2. For structural steel construction, utilize steel columns (bond top and bottom) in lieu of down lead conductors – every other column and not to exceed an average of 60 foot spacing.

F. Conceal system conductors and interior conductors.

G. Notify Architect at least 48 H before concealing lightning protection system components.

H. Below-grade or concealed cable connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

I. Exposed cable connections: Use approved mechanical connections.

J. Air terminals mounted on single-ply roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. For roofing work, refer to Division 07 - Thermal and Moisture Protection.

K. Attach each down conductor to the grounding electrode by bolting connector.

L. Provide grounding electrodes with top 2 ft below finished grade.

M. Ramps and covered passageways shall be protected by the lightning protection system.

N. For construction utilizing post tensioning systems to secure precast concrete sections, do not use the post tension rods as down conductors. Bond tension rods to the lightning protection and grounding system – follow recommendations of the post tension rod manufacturer.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Master Label Certificate.

B. Verify that lightning protection surge arrestor devices are installed on all incoming power and communications lines, in order to obtain UL Master label Certificate.

C. Test grounding system to ensure continuity. Check that resistance to earth does not exceed 25 ohms, measured by “Fall-of-Potential” method.

D. Make resistance measurements in dry weather not earlier than 48 H after rainfall.

E. Make visual inspection to verify that there are no loose connections that may result in high resistance joints, and conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

F. Photograph all concealed components of the system such as grounding electrode connections, down conductors and connections to reinforcing steel. Identify locations where each photograph was taken.

END OF SECTION 264113

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SECTION 264300 - SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 - General Electrical Requirements

B. Section 26 0526 - Grounding and Bonding for Electrical Systems

C. Section 26 2413 - Switchboards

D. Section 26 2416.13 - Lighting and Appliance Panelboards

E. Section 26 2416.16 - Distribution Panelboards

F. Section 26 2726 - Wiring Devices

1.2 DESCRIPTION

A. Provide Type 1 Surge Protective Devices (SPD) for the protection of AC electrical circuits formerly known as Transient Voltage Surge Suppression (TVSS) System. Provide high energy surge current diversion and be suitable for application in Type 1 environments.

B. Modes of Protection:

1. Line to Ground, Line to Neutral and Neutral to Ground for services with a neutral
2. For Services without a neutral, Line to Line and Line to Ground

C. Provide common and normal modes of protection.

1.3 REFERENCE STANDARDS

A. ANSI/UL 1449 Surge Protective Devices Third Edition or Newer

B. IEEE 587

C. FIPS PUB 94

D. IEEE C62.11 – Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (> 1 kV)

E. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

F. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

G. IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits

H. IEEE C62.62 IEEE Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000V and less) AC Power Circuits

I. National Electrical Code – Article 285

J. NEMA LA 1 – Surge Arresters

K. National Fire Protection Association – NFPA 20, 70, 75, and 780

L. UL 96A Installation Requirements for Lightning Protection Systems

1.4 SUBMITTALS

A. Submit Shop Drawings for equipment provided under this Section.

B. Submit shop drawings and product information for approval and final documentation in quantities listed according to Conditions of the Contract. Identify customer name, customer location, and customer order number.

C. Submit ANSI/UL 1449 Listing documentation to indicate the following:

1. Short Circuit Current Rating (SCCR)
2. Voltage Protection Ratings (VPRs) for all modes
3. Maximum Continuous Operating Voltage rating (MCOV)
4. Nominal Discharge Current rating (I-n)
5. Type 1 device
6. VPR, MCOV, I-n, and Type 1 information is posted at www.UL.com under Certifications; search using UL Category Code: VZCA. SCCRs are posted in manufacturer's published documentation.
7. UL data and visual inspection takes precedence over manufacturer's published documentation.

D. Provide shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing field connections, and manufacturer's recommended wire and breaker sizes (if required).

E. Upon request, modules using encapsulation shall be presented without encapsulation for visual inspection, proprietary technology included. MOV type and quantity shall reflect kA ratings on cutsheets, verification of diagnostic monitoring, thermal and overcurrent protection, etc.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Acceptable manufacturers:

1. Advanced Protection Technologies, Inc. (APT)
2. Thomas & Betts; Current Technology
3. LEA International
4. Emerson; Liebert Corporation
5. Mersen
6. Erico

2.2 PERFORMANCE CHARACTERISTICS

A. SPD shall bear the UL Mark and shall be Listed to Third Edition of ANSI/UL 1449. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet intent of specification.

B. Post SPD and performance parameters at www.UL.com under Category Code: VZCA. Products or parameter without posting at UL.com are not approved.

C. Minimum surge current capacity for Service Entrance units based on 8 x 20 microsecond current waveform:

1. 200,000 A between each phase for line-to-line mode
2. 100,000 A each phase for line-to-ground mode
3. 100,000 A each phase for line-to-neutral mode
4. 100,000 A for neutral-to-ground mode

D. Minimum surge current capacity for panelboard units based on 8 x 20 microsecond current waveform:

1. 100,000 A between each phase for line-to-line mode
2. 50,000 A each phase for line-to-ground mode
3. 50,000 A each phase for line-to-neutral mode
4. 50,000 A for neutral-to-ground mode

E. Current Rating:

1. Rated for continuous current and AIC rating of equipment protected.
2. Mark SPD Short-Circuit Current Rating on the SPD label.

2.3 OPERATING CONDITIONS

A. Temperature range: -40°F to 122°F

B. Relative humidity range: 0 to 95%, non-condensing

C. Audible noise level: > 40 dBA at 5 ft

D. SPD Surface Temperature: less than131°F

2.4 FABRICATION

A. SPD Modules:

1. UL Labeled as Type 1 (verifiable at www.UL.com), intended for use without need for external or supplemental overcurrent controls. Protect suppression component of every mode, including N-G, by internal overcurrent and thermal overtemperature controls. SPDs relying on external or supplementary installed safety disconnects do not meet intent of specification.
2. UL Labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Mater label and NFPA 780
3. Suppression components: Heavy-duty MOVs, selenium cells, or combination of both.
4. Provide surge current diversion paths for all modes of protection: L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
5. Provide service entrance SPD audible diagnostic monitoring by way of audible alarm.
6. Provide visual LED diagnostics including a minimum of 1 green LED indicator per phase, and 1 red service LED. Include an audible alarm with on/off silence function and diagnostic test function.
7. If a dedicated breaker for the SPD is not provided in the switchboard, or panelboard include an integral UL Recognized disconnect switch. Dedicated breaker to serve as a means of disconnect for distribution SPDs.
8. Meet or exceed the following criteria:
   a. ANSI/UL 1449 Listed Voltage Protection Ratings (VPRs) for 6kV 3000A testing as follows:

VOLTAGE	**L-N** **L-G** **N-G**	**L-L**
208Y/120V	≤1000V	≤1200V
480Y/277V	≤1200V	≤2000V

9. ANSI/UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	**Allowable System Voltage Fluctuation (%)**	**MCOV**
208Y/120	15%	150V
480Y/277	15%	350V

10. Provide warranty for a period of 10 yrs, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

B. Service Entrance:

1. Install 1 primary suppressor external to the service entrance in accordance with manufacturer instructions.
2. Install SPD on line or load side.
3. Bond SPD ground to service entrance ground.

C. Panelboards:

1. Install 1 suppressor external to each designated panelboard.
2. Install surge suppression device in accordance with manufacturer instructions.

D. SPD Low-Impedance Interconnect Cable:

1. Provide low-impedance cable specifically listed for SPD installations.
2. Low impedance approximately 25% of conventional pipe and wire for improved clamping voltage.

PART 3 - EXECUTION

3.1 APPLICATION OF SPD

A. Provide UL approved disconnect switch at Service Entrance or Transfer Switch as a means of service disconnect if a breaker sized per manufacturer's recommendations is not available.

B. Provide independent means of servicing disconnect at panelboards and switchboards such that the protected panel remains energized. A 30A breaker (or larger based on manufacturer's recommendations) may serve this function.

C. Provide SPD for each panelboard and switchboard associated with the Emergency branch of power.

3.2 INSTALLATION

A. Install per manufacturer's recommended practices.

B. Provide short and straight conductors not exceeding 3 ft in length. Manufacturer-approved cables may be used that allow conductor length to extend beyond 3 ft in length without affecting capability of unit.

C. Input conductors twisted together to reduce inductance.

D. Avoid 90-degree bends in cable.

3.3 QUALITY ASSURANCE

A. Factory test system before shipment. Include quality control check, "Hi-Pot" tests at 2 times rated voltage plus 1,000 V, ground leakage tests, and calibration.

B. Manufacturer Qualifications: Engage a firm with at least 5 yrs experience in manufacturing surge protective devices.

C. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 yrs. When requested by Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with requirement.

D. Provide SPD compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

3.4 FIELD QUALITY CONTROL

A. Inspections before SPD startup:

1. Visual Inspection:
   a. Verify installation per drawings.
   b. Verify phase, neutral, and ground conductors are properly sized and configured.

2. Mechanical Inspection:
   a. Check connections for tightness.
   b. Check terminal screws, nuts and/or connectors for tightness.

3. Electrical Inspection:
   a. Confirm input voltage.
   b. Confirm phase, neutral and ground connections are proper.

3.5 WARRANTY

A. Provide 10 yr manufacturer warranty.

END OF SECTION 264300

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 - General Electrical Requirements

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0526 - Grounding and Bonding for Electrical Systems

D. Section 26 0533 - Raceway and Boxes for Electrical Systems

E. Section 26 0923 - Lighting Control Devices

1.2 DESCRIPTION OF WORK

A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.

B. Luminaires shall be provided complete with necessary accessories for proper installation.

C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified, scheduled or necessary for proper installation shall be included.

D. Provide lamps for luminaires as recommended by luminaire manufacturer.

E. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.

F. Work includes final aiming and focusing of luminaires under direction of the Architect/Engineer.

1.3 REFERENCE STANDARDS

A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)

B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)

C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)

D. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility

E. UL 676 – Underwater Luminaires and Submersible Junction Boxes

F. UL 924 - Emergency Lighting and Power Equipment

G. UL 1574 – Track Lighting

H. UL 1598 – Luminaires

I. UL 1838 – Low Voltage Landscape Lighting Systems

J. UL 2108 – Low Voltage Lighting Systems

K. UL 2388 – Flexible Lighting Products

L. UL 2562 – Pendant Cable

M. UL 8750 – LED Light Sources for use in Lighting Products

N. ANSI C78.377 – Chromaticity

O. IESNA LM-79 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

P. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources

Q. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A

1.4 QUALITY ASSURANCE

A. Luminaire and accessory components shall be constructed of materials appropriate for their use.

B. Luminaires, drivers, lamps and other components shall meet the requirements of all applicable State and Municipal codes and energy codes.

C. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.

D. Contractor shall coordinate installation of lighting systems with all trades.

1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect, Engineer.
2. Multiple Name Specification:
   a. When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.
   b. Products of the same type shall be of same manufacturer.

3. Single Name Specification:
   a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.
   b. Specifier has secured accurate pricing for all single name products prior to bidding and has shared this information with Architect/Owner's Representative. Contractor shall supply contractor net unit pricing for all single name products specified. Unit

price shall be for equipment only and not include installation or miscellaneous electrical costs.

4. Contractor shall coordinate and verify compatibility of luminaires with lighting control system
   a. Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.

E. Substitution requests:

1. Will be evaluated prior to Bid.
2. Shall follow procedures set forth in this Section under paragraph 1.7 and in Section 01 2500 - Substitution Procedures.
3. Shall be made not less than 10 days prior to bid date.
4. Shall include the following information indicating that the proposed substitution is of similar construction quality and assembly, lumen output and distribution, color temperature, color consistency, and controllability:
   a. Specified and proposed manufacturer's product data sheet, noting options and features.
   b. Provide dimensioned drawing of luminaire.
   c. Provide photometric data in form of an electronic IES file on CD, USB or via email for use in a recognized computer lighting program.

5. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.
6. When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to owner to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.
7. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.
8. For all luminaire types using an LED light source, provide independently tested, IESNA LM79 compliant photometry testing data and IESNA LM-80 Lumen Maintenance data.

1.5 WARRANTY

A. Exit Signs Utilizing LED lamp Technology: Provide manufacturer’s warranty for a period of not less than five years from the date of substantial completion including parts and labor for full replacement of defective product.

B. LED Luminaires: Provide Manufacturer’s warranty for a period of not less than five years from the date of substantial completion or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver

1.6 SUBMITTALS

A. After award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, they shall bring it to the attention of Owner/Architect at this time.

B. In addition to complying with requirements of Section 26 0000 - General Electrical Requirements, submittals shall include the following:

1. Manufacturer's product data
2. Installation instructions
3. Maintenance data
4. Parts list for each luminaire accessory
5. Photometric Data: photometric data for luminaire, including optical performance as follows:
   a. Coefficients of utilization
   b. Luminance table
   c. Candela distribution data
   d. Zonal lumens
   e. Area and roadway luminaires shall include Isocandela Charts, IES Roadway Distribution Classification and IES BUG (Backlight – Uplight – Glare) ratings.
6. Driver schedule indicating manufacturer, type, and catalog number for each luminaire
7. Driver cut sheet for each driver used, referencing luminaire type(s)
8. Lamp schedule indicating manufacturer, type, and catalog number for each luminaire
9. Lamp cut sheet for each lamp used, referencing luminaire type(s)
10. Documentation of LED and driver compatibility
11. Product color/finish
    a. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection.

C. Shop Drawings for equipment provided under this Section shall include the following:

1. Overall submittal drawings indicating luminaire size, mounting (including ceiling type), light source, shielding, and voltage attributes, as well as manufacturer's product data, installation instructions, maintenance data, and parts list for each luminaire.
2. Catalog cutsheets lacking sufficient detail will not be accepted.
3. Detailed drawings of linear pendant mounted and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, lamp combinations, driver locations, wiring and controls configuration, luminaire joint locations and end plates. Provide canopy details that indicate coordination with the ceiling system provided.
4. Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates.
   a. For LED strip luminaires mounted in architectural coves, provide dimensioned drawings and sections and include accessory cut sheets as specified. Within coves, all luminaires are to be mounted end to end with no more than 12” unlit split evenly between ends
5. Detailed drawings for LED systems including LED color, color consistency, rated life, warranty, and scale plans with luminaire layout, number, type and location for drivers, and a complete bill of materials.

6. Detailed drawings for continuous recessed or continuous surface mounted LED luminaires including dimensions, power feed locations, driver locations/quantity, luminaire joint locations, extension plates for end and corner sections and end plates as applicable.
7. Detailed drawings for custom LED handrail systems including dimensions, power feed locations, driver locations/quantity, luminaire joint locations as applicable.
8. For LED luminaires, submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer and lighting control manufacturer shall be financially responsible for any incompatibilities.
9. Detailed drawings for nonstandard/custom luminaires indicating dimensions, weights, method of field assembly, components, features, and accessories. Details shall be scaled to a legible size.
10. Detailed drawings for fiber optic systems including scaled plans with cable layout number and type of fiber bundles, illuminator quantity and location, and a complete bill of materials.
11. Drawings for site lighting shall include pole data with wind loading, complete dimensions and finish, pertinent physical characteristics and accessories including mounting details, driver type and location and any specified control options.
12. Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply complete photometric data for luminaire, including optical performance rendered by independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America as follows:
    a. Coefficients of utilization
    b. Luminance table with data presented numerically, showing maximum luminaire luminance at shielding angles. Readings should be taken both crosswise and lengthwise in case of luminaire with an asymmetric distribution.
    c. Candela distribution data, presented graphically and numerically, in 5° increments (5°, 10°, 15°, etc.). Data developed for up and down quadrants normal, parallel, and at 11-1/2°, 45°, 67-1/2° to lamps if light output is asymmetric.
    d. Zonal lumens stated numerically in 10° increments (5°, 15°, etc.) as above.

13. No variation from the general arrangement and details indicated on drawings shall be made on shop drawings unless required by actual conditions. All variations shall be marked on drawings submitted for approval.

D. Provide luminaires with factory or field finish as directed by Architect/Engineer. Verify final finish requirements before releasing luminaires for fabrication.

E. Where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection. Luminaires not having color or finish acceptable to Architect shall be replaced at no additional cost.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Luminaires:

1. As shown on Luminaire Schedule

B. LED Drivers:

1. Shall be manufacturer recommended compatible driver.
2. All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.
3. Manufacturers must be compatible with lighting control system(s) provided and control luminaires from 100% to 1% light output or 100% to 10% light output per Luminaire Schedule and controls intent documents.

C. Emergency LED Drivers:

1. Bodine, Dual-Lite, Iota or as specified in the Luminaire Schedule

D. Low Voltage Transformers:

1. Q-Tran or as specified in the Luminaire Schedule

E. Lamps:

1. General Electric, Osram Sylvania, Philips Lighting
2. Soraa, Ushio, Venture or other manufacturers as noted for specific lamps in the Luminaire Schedule

F. LED Modules:

1. Philips Lumileds, Xicato, Cree, GE, Nichia, Osram Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.2 FABRICATION AND MANUFACTURER

A. Luminaires:

1. Construction
   a. Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
   b. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
   c. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
   d. Surface temperatures of luminaires with integral drivers shall not exceed 90°C in 30°C ambient.
   e. Luminaires recessed in ceilings utilized as air handling plenums shall be certified as suitable for the purpose and conform to NEC Article 300.
   f. Miter cuts shall be accurate, joints shall be flush and without burrs.
   g. LED troffers with doors shall have spring-loaded door cam latches.
   h. Luminaires shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance documented. Low voltage transformers and drivers shall be vented per manufacturer's specifications.
   i. Provide inscription for exit and stairway signs to conform to applicable codes.
   j. Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.

k. Coordinate recessed luminaire mounting appurtenances, flanges and trims with construction of ceiling in which luminaire is to be recessed. Provide correct luminaire mounting assembly.
l. Luminaire frames shall be manufactured of non-ferrous metal or be suitably rust proofed after fabrication.

2. LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control, mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:
   a. Be UL listed or equivalent. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.
   b. Be tested to IESNA LM-79-08 testing using absolute photometry criteria.
   c. Be rated at > or = to 70% lumen maintenance at 50,000 hours of operation.
   d. Be rapid cycle stress tested.
   e. Have integral lamp modules with a minimum operating temperature of -20°C.
   f. Have lamp modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.
   g. Have driver housings easily accessible for ease of maintenance.
   h. Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.
   i. Be RoHS compliant, lead and mercury free.
   j. Have an LED operating frequency of + or – 120 Hz.
   k. Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)
   l. Be Class A Sound rated.
   m. Be supplied with power supply that complies with IEEE C. 62.41-1991.
   n. Operate at 120 or 277 volts, ±10%.
   o. Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.

3. Lenses, Reflectors and Diffusers
   a. All lenses or louvers shall be removable, but held so that normal motion will not cause them to drop out.
   b. All glass used in incandescent or LED luminaires shall be made from thermal shock resistant borosilicate glass.
   c. Optical lenses shall be free from spherical and chromatic aberrations.
   d. Acrylic lenses shall be 100% virgin acrylic material.
   e. Diffuser materials shall be UV stabilized in applications exposed to sunlight.
   f. LED troffer lenses shall be 0.125” thick, unless otherwise noted.
   g. Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.
   h. Reflector cones shall not have visible lamp flashing in the cone.

4. Optics and Adjustments
   a. Lamp holders shall be suitable for the indicated lamps and shall be set such that lamps are positioned in optically correct relation to all luminaire components.
   b. Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.

5. Finishes
   a. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
   b. Painted luminaires shall be painted after fabrication or "post painted".
   c. Ferrous parts and supports shall be rust proofed after fabrication.
   d. For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.

6. Wiring
   a. Luminaires shall be completely wired at the factory and as required by code.
   b. Internal wiring shall contain no splices.
   c. Connections shall be made with insulated "wire nut" type mechanical connectors except that driver connections shall comply with NEC Article 410.
   d. Wire for connections to lamp sockets and lamp auxiliaries shall be minimum #16 AWG luminaire wire.
   e. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
   f. Recessed incandescent luminaires shall incorporate integral thermal protection.
   g. Incandescent luminaires shall be wired with heat resistant wire.
   h. Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.
   i. Provide dual-level switching for luminaires as indicated on luminaire schedule and/or where shown on Contract Drawings. Typically first switch designation controls outboard lamps, and second switch designation controls inboard lamp(s), unless noted otherwise.
   j. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
   k. Provide lamps for all luminaires.

7. Ceiling Coordination
   a. Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.
   b. Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.
   c. Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.

8. Track-Lighting Systems:
   a. A lighting track system is defined as a manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length may be altered by addition or subtraction of sections of track. Lighting track may be either flexible or rigid depending on the specific application.
   b. Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.
   c. All line voltage track lighting systems shall be provided with integral current limiters or be fed from supplementary overcurrent protection panels to limit power consumed by track.
   d. Lighting track system includes current carrying conductors which may convey either line voltages (120V or 277V) or low voltages (12V or 24V). Characteristics of lighting track that conveys line voltages are different than a lighting track system that conveys low voltages and as such are governed by different requirements. Therefore, they are considered individually in these Specifications.

1). Line voltage (120V or 277V) Lighting Track systems:
   a). Provide components, including track, fittings, and luminaires from the same manufacturer as recommended by manufacturer for the intended use. All components shall be UL Listed and comply with the National Electric Code Standards for Lighting Track.
   b). Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of live and neutral conductors must always be maintained along continuous run so that track fittings connect into the track in a consistent manner.
   c). Support lighting track at intervals recommended by the track manufacturer.
   d). One or two circuit Lighting Track shall be supplied with separate neutral busbars and have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage luminaires with either magnetic or electronic transformers.
   e). Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run.
   f). One and two circuit 120 volt Lighting Track shall be rated at 120/250 volt, 60 Hz, 2,400 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
   g). One and two circuit 277 volt Lighting Track shall be rated at 277 volt, 50/60 Hz, 5,540 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
   h). A separate grounding busbar shall be integral in all track lengths.
   i). 277 volt Track fittings shall be identified by a red rotor and a 277 volt label.
2). Low voltage (12V or 24V) Lighting Track systems:
   a). Provide components, including track conductors, remote mounted transformers, fittings, and luminaires from the same manufacturer as recommended by the manufacturer for the intended use. Components shall be UL Listed as applicable for low voltage use.
   b). Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of conductors must always be maintained along continuous run so that track fittings connect into track in a consistent manner.
   c). Support lighting track at intervals recommended by track manufacturer.
   d). One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track can only be dimmed if both circuits are fed from the same transformer and as a result, separate circuit dimming shall not be attempted or permitted.
   e). All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.
   f). Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.

g). Conductors used in low voltage Lighting Track shall be, at minimum, equivalent to #10 AWG 30 amp wire or heavier and be capable of carrying a 300 watt load (at 12 volts) up to 32 ft from transformer feed within range of luminaire voltage tolerance. At 24 volts, conductors shall be capable of supplying a 600 watt load up to 60 ft from transformer feed within range of luminaire voltage tolerance.

h). If taut strung cable conductors are used as low voltage Lighting Track system, they shall have a Kevlar core to prevent strain on outer current carrying conductors.

i). Only insulated type taunt strung cable conductors shall be used in order to comply with local electrical codes governing installation.

9. Outdoor Lighting Systems:
   a. Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit
   b. Provide poles as shown on luminaire schedule.
      1). Poles shall have hand-holes.
      2). Fusing for each luminaire head shall be located in hand-hole near base of pole.
      3). Pole base anchor bolts shall be galvanized.
   c. Exterior Luminaires:
      1). Shall operate at a minimum ambient temperature of 0°F.
      2). Shall be fully gasketed, with UL wet location label.
      3). Shall have approved wire mesh screens for ventilation openings.
      4). Anodized aluminum reflectors shall have minimum of 0.00079” anodizing thickness.
   d. Pole/Luminaire combination shall have EPA rating that will withstand site wind conditions.
   e. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
   f. Aluminum surfaces shall receive a duronodic or polyester powder paint finish.
   g. Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
   h. Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
   i. Provide 1/8” thick x 2” diameter solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.3 DRIVERS

A. LED Drivers and Power Supplies shall:

1. Operate system LEDs within the current limit specification of the LED manufacturer.
2. Be supplied with over-temperature protection circuitry.
3. Be within a NEMA enclosure.
4. Be equipped with knockouts to accommodate standard conduit sizes
5. Have a Power Factor to be = or > than 0.9
6. Have a Lamp Current Crest Factor < 1.5
7. Dimmable LED drivers must be compatible with dimming system(s) provided and control luminaires per luminaire schedule and controls documentation.

8. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
9. Class A sound rated
10. Equipped with resetting thermal sensitive device.
11. For operation at 60 Hz and voltage as scheduled.
12. Meet or exceed all ANSI or NEMA standards
13. Capable of operating LEDs with less than 5% flicker
14. Be DMX compatible in Color changing LED luminaires.

B. LED Data Enablers shall be:

1. Compatible with DMX
2. NEMA enclosure
3. Equipped with knockouts to accommodate standard conduit sizes
4. Convection cooled
5. RoHS compliant

C. Emergency LED Drivers shall:

1. Be UL 924 listed
2. Operate LED luminaire at 10W minimum output for 90 minutes
3. Have high temperature nickel-cadmium battery.
4. Be installed on top of luminaires
5. Have solid state charging
6. Battery to be recharged within 24 h
7. Automatic testing every 30 days for 30 seconds and once a year for 90 minutes. Provide with flashing indicator light and audible alarm.

2.4 LOW VOLTAGE TRANSFORMERS

A. Transformers shall be:

1. Sized to compensate for voltage drop over indicated distances
2. Locally fused

B. Transformers shall have line voltage switch within reach.

C. Provide adequate ventilation to meet code and manufacturers requirements.

2.5 LAMPS

A. Provide lamps as noted on Luminaire Schedule.

B. Provide lamps of same type from same manufacturer.

C. Where a specific lamp manufacturer has been indicated in the Luminaire Schedule, lamps shall be supplied from named manufacturer only.

D. White LED sources shall be:

1. Minimum CRI of 80 unless noted otherwise on Luminaire Schedule

2. Less than 5% flicker
3. Within 0.004 on the CIE 1976 diagram for color spatial uniformity
4. Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source
5. Binned within a 2-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule
6. Color temperature as noted on Luminaire Schedule
7. Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
8. L70 rated life shall be a minimum of 50,000 hours, unless noted otherwise.
9. LED modules, unless noted otherwise, shall be provided by light fixtures manufacturer and integral to luminaire.

E. Provide all other lamp types and special purpose lamps as noted on Luminaire Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Marking:

1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
2. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when lamps are in place.

B. Installation of Luminaires:

1. Lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.
3. Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.
4. Locations
   a. Install luminaires at locations and heights as indicated.
   b. Do not scale electrical drawings for locations of luminaires.
   c. Architectural reflected ceiling plans show locations of luminaires.
   d. Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Architect/Engineer prior to installation.
   e. Where luminaires are to be concealed, or surface mounted in highly visible public spaces, a small sampling of luminaires shall be installed, adjusted and aimed for Architect/Engineer's review approval, prior to installing remaining luminaire of same type.
   f. Mount all luminaires so as to maintain full range of motion.
   g. Install luminaires plumb, square, and level with ceilings and walls.

h. Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions. Provide extra length of adjustable supports where diffusers are mounted directly above light fixtures to facilitate air balancing efforts.
i. Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:
   1). Suspended so that bottom of luminaire is no higher than bottom of obstruction
   2). Located at height of lowest luminaire
   3). Minimum height: 8'-0"
   4). Shall not be located until locations of obstructions are determined.
   5). Where a minimum height of 8'-0" is unachievable, wall mounted luminaires will be utilized.

5. Support
   a. Support surface mount luminaires from building structure.
   b. Metal decking shall not be pierced for luminaire support.
   c. Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.
   d. LED troffers shall be held in place by support clips.
   e. Provide plaster frames for recessed luminaires in plaster ceilings.
   f. Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.
   g. Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.
   h. Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.
   i. Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.
   j. Recessed luminaires shall be supported with 12 ga wire hangers, 2 per luminaire, at diagonally opposite corners.
   k. Recessed fluorescent and LED troffers and luminaires over 55 lbs, such as 4' x 4' shall be supported with 12 ga wire hangers, 4 per luminaire, 2 at 45 degree diagonals, and two perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaires weight.
   l. In areas with seismic requirements, suspended or pendant mounted luminaires shall be able to swing 45 degrees in any direction without hitting an obstruction. In the event hitting an obstruction is unavoidable, guy wires will be used to secure the luminaire in place.
   m. Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga wire.
   n. Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga wire installed from box to structure.
   o. Support surface mounted luminaires greater than 2 ft in length at a minimum of each additional 2 ft, or as recommended by manufacturer.
   p. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.
   q. Rigidly align continuous rows of luminaires.

6. Mounting and Enclosures
   a. Install flush mounted luminaires to eliminate light leakage.
   b. For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.

c. Provide approved fire rated enclosures around luminaires in fire rated ceilings.

7. Conduit and Wiring
   a. Wire for connections to lamp sockets and auxiliaries shall be suitable for temperature, current, and voltage conditions.
   b. Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 72”, with THHN conductors and green wire ground conductor.
   c. Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the architect for all exposed conduit runs prior to rough in.

8. In-Grade Luminaires:
   a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
   b. Provide adequate drainage system per manufacturer's recommendations.

C. Installation of Outdoor Pole Bases

1. Contractor shall provide bases for luminaires.
2. Provide handhole for electrical connection within 4’-0” of pole base.
3. Contractor shall:
   a. Rough-in conduits
   b. Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.

4. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect/Engineer.

D. Pole Installation:

1. Install luminaires, poles, hardware, etc., for complete system.
2. Use web fabric slings (not chain or cable) to raise and set poles.

E. Lamps:

1. Provide new lamps delivered in original manufacturer’s cartons.
2. LED lamps shall be energized continuously for not less than 100 hours for proper seasoning.

F. Grounding:

1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems".
2. Poles:
   a. Install 10 ft driven ground rod at each pole.

3. Nonmetallic Poles:
   a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

G. Spare Parts:

1. Provide spare globes and guards, 1 for every 100 of each type and rating installed. Furnish at least one of each luminaire family.
2. Provide spare louvers and reflector cones, 1 for every 100 of each luminaire family. Furnish at least one of each type.
3. Provide spare plastic diffusers and lenses, 1 for every 100 of each luminaire family and rating installed. Furnish at least one of each type.
4. Provide 5% spare lamps for each type in Luminaire Schedule
   a. Spare lamps shall be delivered to Owner in new condition and in original packaging.
   b. Manufacturer and model number shall match those installed in the project's luminaires.

5. Provide 1% spare replaceable LED lamp modules for each primary fixture series type in Luminaire Schedule
   a. Spare LED lamp modules shall be delivered to Owner in new condition and in original packaging.
   b. Manufacturer and model number shall match those installed in the project's luminaires.

6. Provide spare LED drivers, 1 for every 100 of each primary fixture series type and rating installed. Furnish at least one of each type.
   a. Manufacturer and model number shall match those installed in the project's luminaires.

7. Provide 1% spare LED luminaires with non-replaceable lamp modules consisting of entire LED luminaire assembly and driver(s).

3.2 SUBSTANTIAL COMPLETION

A. Quality Control:

1. At Date of Substantial Completion, replace lamps/LED modules/LED luminaires which are not operating properly.
2. Replace any lamps used as worklights during construction phase.
3. Protection wrapping on lensed or louvered luminaires shall be removed before installation of furniture, but after finish work is complete.
4. Deliver spare equipment to Owner's representative.

B. Tests:

1. Give advance notice of dates and times for field tests.
2. Provide instruments to make and record test results.
3. Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.
4. Verify operation of luminaires with lighting control system and daylight harvesting systems. Any dimmed fixtures shall exhibit no signs of flickering.
5. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
6. Report results of tests.

C. Adjusting and Cleaning:

1. Clean luminaires of handling marks, dust and dirt.

2. Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.
3. Damaged luminaires or components shall be replaced with new.
4. Keep luminaires clean and protected for remainder of construction period.
5. Verify orientation of directional luminaires prior to installation.
   a. This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at direction of Architect/Engineer. These electricians shall be available at times designated by Architect/Engineer and shall be provided at no extra charge to Owner over base bid. Contractor shall provide equipment for luminaries' focus including ladders and mechanical lifting systems.

6. Program preset dimming system lighting levels.
7. Program ambient light sensors integral to luminaires for appropriate illumination levels as indicated in control narrative or in lighting control specifications.
8. Program occupancy sensors integral luminaires for appropriate time delay as indicated in control narrative or in lighting control specifications.
9. Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.
10. No light leaks shall be permitted at ceiling line from any visible part or joint.

D. Training

1. Contractor shall provide Owner with 3 complete copies of Operations and Maintenance manuals.
   a. All "Approved as Noted" comments shall be corrected/picked-up in this record manual set.
   b. Each manual shall contain specific information pertaining to the equipment installed. Each manual shall contain at a minimum:
      1). Detailed as built shop drawings for all lighting equipment installed.
      2). Manufacturer's product cut sheets for all equipment installed keyed by type as to as built drawings.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps
      3). Manufacturer's complete installation instructions for all equipment installed keyed by type to as built drawings.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps
      4). Equipment maintenance requirements and schedules.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps/LEDs
      5). Equipment manufacturer contacts.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps/LED modules
      6). Equipment manufacturer warranties.
         a). Luminaires
         b). Control gear/drivers
         c). Lamps/LED modules

2. Contractor shall provide qualified personnel onsite to provide a minimum of three days of training to Owner's representatives.
3. This training shall cover:
    a. Luminaire use and maintenance
    b. Architectural lighting system use and maintenance
    c. Group relamping cycles

END OF SECTION 265000

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SECTION 270000 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section details references, standards, guidelines, requirements and conditions common to all Division 27 work.

B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

G. Where architectural features govern location of work, refer to architectural drawings.

H. All work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0526 - Grounding and Bonding for Communications Systems
2. Section 27 0528.29 - Hangers and Supports for Communications Systems
3. Section 27 0528.33 - Raceway and Boxes for Communications Systems
4. Section 27 0528.36 - Cable Tray for Communications Systems
5. Section 27 0528.39 - Surface Raceways for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1000 - Structured Cabling
8. Section 27 1100 - Communications Equipment Room Fittings
9. Section 27 1300 - Communications Backbone Cabling
10. Section 27 1500 - Communications Horizontal Cabling
11. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

B. Related sections in other Divisions of Work:

1. Section 26 0593 – Electrical Systems Firestopping
2. Also refer to individual technical sections identified above.

C. Utility Services:

1. Revise to include Telecom Utility language.

D. Temporary Services:

1. Refer to Division 01 - Temporary Facilities and Controls.

E. Continuity of Service:

F. Cleaning and Repair

1. Clean and repair existing materials and equipment that remain or is to be reused.

G. Concrete Work:

1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.

H. Painting:

1. Furnish equipment with factory applied prime finish unless otherwise specified.
2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.
3. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.
4. Contractor is responsible for painting of plywood in Telecommunications Equipment Rooms. Refer to Drawings.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.5 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:

1. ANSI/NFPA 70 - National Electrical Code
2. Local Electrical Code
3. Country, state and local health, safety and building codes
4. UL 444 - Communications Cables
5. Standards identified in individual Technical Sections.
6. BICSI Telecommunications Distribution Methods Manual (TDMM)
7. TIA 568-C.0 through C.3 - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
8. TIA 569-B - Commercial Building Standard for Telecommunications Pathways and Spaces

B. Agencies or publications referenced herein refer to the following:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society for Testing and Materials
4. BICSI Building Industry Consulting Services International
5. EIA Electronic Industries Alliance
6. FIPS Federal Information Processing Standards
7. FCC Federal Communications Commission
8. ICEA Insulated Cable Engineers Association
9. IEEE Institute of Electrical and Electronics Engineers
10. NEC National Electrical Code
11. NECA National Electrical Contractors Association
12. NEMA National Electrical Manufacturers Association
13. NESC National Electrical Safety Code
14. NETA National Electrical Testing Association
15. NFPA National Fire Protection Association
16. NIST National Institute of Standards and Technology
17. OSHA Occupational Safety and Health Administration
18. TIA Telecommunications Industry Association
19. UL Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 DEFINITIONS

A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.

1. Entrance facility - an entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.
2. Entrance Room - room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarcation (DEMARC) is typically located here.
3. Equipment Room (Telecom): an environmentally controlled centralized space for telecommunications equipment that usually houses main or intermediate cross-connect.

Backbone cabling, cabling to Building Entrance and horizontal cabling may be terminated here.

4. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
5. Intra-building - within single building.
6. Inter-building - between 2 or more buildings.
7. IP Telephony – Use of Internet Protocol (IP) for two-way transmission of conversations. Sometimes referred to as “Voice over Internet Protocol (VoIP)”.
8. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.
9. Voice over Internet Protocol – Refer to IP Telephony.

B. Typical NEMA Enclosures and Usage

1. Refer to Section 26 0000 – General Electrical Requirements.

1.7 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. AFF Above Finished Floor
2. ATM Asynchronous Transfer Mode
3. AWG American Wire Gauge
4. BAS Building Automation Systems
5. BTU British Thermal Unit
6. CATV Community Antenna Television
7. CCTV Closed-Circuit Television
8. CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
9. cm centimeters
10. °C degrees Celsius
11. °F degrees Fahrenheit
12. DTMF Dual Tone Multi Frequency
13. EIA Electronic Industries Alliance
14. EF Entrance Facility
15. ER Entrance Room
16. EIDF Equipment Intermediate Distribution Facility
17. FDDI Fiber Distributed Data Interface
18. ft feet
19. GbE Gigabit Ethernet
20. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
21. ID Inside Diameter
22. in inch
23. IPT IP Telephony
24. kg kilogram
25. lbs pounds
26. LAN Local Area Network
27. MATV Master Antenna Television
28. MC Main Cross-connect
29. m meters
30. mm millimeters
31. Mbps Megabits per second

32. µm micrometer (10^{-6} meter)
33. OD Outside Diameter
34. PBX Private Branch Exchange (Telephone Switch)
35. pF pico-Farad (10^{-12} Farad)
36. PVC Polyvinyl Chloride
37. RU Rack Unit
38. sq ft square feet (area)
39. TP-PMD Twisted Pair Physical Layer Medium
40. WAN Wide Area Network
41. WLAN Wireless Local Area Network
42. VoIP Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.8 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.9 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
3. Mark catalog sheets and drawings to indicate specific items submitted.
   a. Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
   b. Where sheet includes multiple product options, mark proposed option(s).

4. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
5. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
6. Group submittals by Section to include complete documentation of related systems, products and accessories. Where applicable, dimensions shall be marked in units to match those specified.
7. Submittals shall be in electronic form or on paper per Division 01.
   a. Documents in electronic form shall be ADOBE *Acrobat* PDF.
   b. Paper documents shall be original catalog sheets or photocopies thereof.
   c. Facsimile (fax) sheets will not be accepted.

8. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
9. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
10. Include wiring diagrams for electrically powered or controlled equipment.
11. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.

12. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
13. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
14. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 - Operation and Maintenance Data.
2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
4. Manuals shall include the following:
   a. Copies of shop drawings
   b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
   c. CD ROM's of O&M data with exploded parts lists where available
   d. Phone numbers and addresses of local parts suppliers and service companies
   e. Internet/WEB page addresses where applicable
   f. Wiring diagrams
   g. Start up and shut down procedure
   h. Factory and field test records
   i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section

5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. O&M manuals and instructions to Owner shall be provided prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.

1.10 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:

1. Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged, to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:

1. Refer to Division 01 - Closeout Procedures.
2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.11 WORK BY OWNER

A. Owner will provide:

1. Active electronics for interface with building voice and data cabling systems
2. Connections from telephone and data equipment to Contractor provided cabling.
3. Passive Broadband distribution hardware (coaxial cable taps and splitters)
4. Active Broadband headend and distribution hardware (video processing, distribution amplifiers, etc.)

1.12 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

1.13 GUARANTEE

A. Refer to Division 01 for general Guarantee (Warranty) requirements.

B. Refer to technical sections for Guarantee requirement for each system.

1. Where no guarantee requirements are called out, guarantee as called out in Division 01 equipment, materials, and workmanship to be free from defect.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

G. Openings for penetrations shall be minimum 1/2" larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

H. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

I. Seal non-rated wall openings with urethane caulk.

J. Finish and trim penetrations as shown on details and as specified hereinafter.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.

D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.

E. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

F. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted.

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.7 CABLE PROTECTION

A. Protect cabling and termination components from contact with, and potential application of, foreign materials.

1. Foreign material is defined as material that is not part of cabling assembly and termination components when delivered from manufacturer.
2. Examples include paint overspray and drywall compound.

B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.

1. Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

3.8 HOUSEKEEPING PADS

A. Not applicable to this Division of work.

3.9 ACCEPTANCE TESTING

A. Prior to testing, submit to owner (or Owner's representative) and Engineer, proposed schedule for acceptance testing.

1. This notification shall be minimum of 10 working days in advance to allow for participation by Owner and/or Engineer.

B. Prior to testing, submit written description of intended test procedures and submit sample test forms to Engineer.

1. Submitted information shall include proposed file naming format to be used in identifying cable, pair or optical fiber which is subject of test record.
2. Failure to provide above information shall be grounds for Engineer or Owner to reject any Documentation of related testing and to require repeat of affected test.

C. Conduct tests during course of construction when identifiable portion(s) of installation is complete.

1. Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.

D. Provide equipment and personnel necessary to conduct acceptance tests.

E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.

F. Document tests.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.

H. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

I. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.10 START-UP

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

3.11 DOCUMENTATION

A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

1. Acceptance Test Results
2. Record Drawings
3. All Approved Submittals
4. Manufacturer’s Warranty Documents

B. Submit System Documentation in accordance with Division 01 "Project Record Documents".

1. Documents shall be submitted in same electronic format in which they were received from the Architect and Engineer.
2. Document updates shall be performed in native software format matching original design team documents.
   a. Scans of hand marked documents shall not be allowed.

3. Update documents to reflect installed conditions for equipment shown on documents.

C. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor, etc.) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.

1. Draft drawings may include mark-ups done by hand.
2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.
3. Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.
4. For structured cabling this includes the horizontal link from the TO to the HC, backbone cabling from the HC to the MC, cross-connections, interconnections and/or patch cords that are the responsibility of the contractor.

D. Submit Acceptance Test Results in electronic form for review and distribution.

1. Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.
2. Final documentation of Test Results shall be submitted on CD-ROM.
3. Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.
4. Where unique software (other than an MS-Word® compatible Word Processor or MS-Excel® spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, (1) licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.

E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.

1. Owner may also perform independent testing to verify results.
2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.

H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.12 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.

C. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION 270000

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SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Grounding and Bonding that are unique to communications systems and not included in Division 26 sections.

1.2 DESCRIPTION

A. Grounding and Bonding infrastructure for communications includes Cabling, Busbars and Connectors.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0528.33 - Raceway and Boxes for Communications Systems
3. Section 27 0528.36 - Cable Tray for Communications Systems
4. Section 27 0528.39 - Surface Raceways for Communications Systems
5. Section 27 0553 - Communications Systems Identification
6. Section 27 1000 - Structured Cabling
7. Section 27 1100 - Communications Equipment Room Fittings
8. Section 27 1300 - Communications Backbone Cabling
9. Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:
1. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition, the following apply:
1. IEEE/ANSI 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.
3. UL 467 Electrical Grounding and Bonding Equipment
4. ANSI J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements which provides information on Definitions used in this and related sections.

B. Additional definitions (per referenced standards):
   1. Telecommunications Main Grounding Busbar: Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.
   2. Telecommunications Grounding Busbar: Interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground, and located in telecommunications room or equipment room.
   3. Telecommunications Bonding Conductor: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
   4. Telecommunications Bonding Backbone: Conductor that interconnects tele-communications main grounding busbar to telecommunications grounding busbar.
   5. Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.
   6. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
   7. Irreversible Compression: Permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements which provides information on Abbreviations and Acronyms used in this and related sections.

B. Additional abbreviations and acronyms (per referenced standards):
   1. Telecommunications Main Grounding Busbar - TMGB
   2. Telecommunications Grounding Busbar - TGB
   3. Telecommunications Bonding Backbone - TBB
   4. Grounding Equalizer - GE

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS BUSBARS

A. Material: Copper (aluminum not permitted)
   1. 1/4” thick

B. Pre-drilled
   1. 3/8” Diameter
   2. Hole spacing per ANSI Joint Standard J-STD-607-A
   3. Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Busbars shall be listed by nationally recognized testing laboratory.

E. Size:
   1. Telecommunications Main Ground Busbar (TMGB) – 20” x 4” (minimum)
   2. Telecommunications Grounding Busbar (TGB) – 12” x 2” (minimum)

2.2 CONDUCTORS

A. Material: Stranded copper (aluminum not permitted)

B. Bonding Conductors shall be insulated.
   1. Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines

C. Size:
   1. Telecommunications Bonding Conductor (TMGB to Grounding Electrode): 3/0 AWG
   2. Telecommunications Bonding Backbone (TBB; TMGB to TGB):
      a. Up to 66 ft - 2/0 AWG
      b. Greater-than 66 ft - 3/0 AWG
   3. Grounding Equalizer (GE):
      a. Up to 66 ft - 2/0 AWG
      b. Greater-than 66 ft - 3/0 AWG

2.3 CONNECTIONS

A. Mechanical Connectors
   1. Connector Body shall:
      a. Be high-strength, high-conductivity cast copper alloy
      b. Be 2 bolt type

2. Bolts, nuts, washers and lock-washers: Silicon Bronze
   a. Shall be supplied as part of connector body
   b. Split bolt connector types are not allowed
3. Connector shall:
   a. Meet or exceed UL 467
   b. Be clearly marked with catalog number, conductor size and manufacturer.

B. Compression Connectors
1. Connector Body: pure wrought copper.
   a. Conductivity shall be no less than 99% by IACS standards.
2. Connector shall:
   a. Meet or exceed performance requirements of IEEE 837, latest revision
   b. Be factory filled with an oxide-inhibiting compound
   c. Be clearly marked with manufacturer, catalog number, conductor size and required compression tool settings
3. Connection shall be irreversible.

C. Exothermic Weld Connections
1. Not Allowed

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

A. Permanently attach communications grounds prior to energizing communications equipment.

3.2 TOPOLOGY

A. Refer to the project drawings.

3.3 INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Grounding infrastructure as specified.

B. Install Products in accordance with manufacturer's instructions.
1. Install Compression Connectors with compression, tool and die system, as recommended by manufacturer of connectors.

C. Grounding connections shall be tight and shall be made with UL listed grounding devices, fittings, bushings, etc.

D. On the Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) all connections shall be Compression type.

E. Locate TGBs and TMGB per drawings.

F. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

1. TGBs shall be bonded to TBB via tap off of TBB.
   a. Exception is "last" TGB on TBB (e.g. furthest from TMGB).
2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.

G. Insulate Busbars from their support.

H. Connections shall be bare metal to bare metal contact.
   1. Clean surfaces of paint, dirt, oil, etc.

I. Connections shall be exposed and visible for inspection at all times.
   1. Do not install insulation over ground connections.

J. Terminate each grounding conductor on its own terminal lug.
   1. Multiple conductors on single lug not permitted.

3.4 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test resistance of each TGB to ground.
   1. Maximum resistance to ground shall be less than 5 Ohms.

3.5 DOCUMENTATION

A. Accurately record actual locations of grounding electrode(s), busbars and backbone grounding conductors.

END OF SECTION 270526

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SECTION 270528.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for items unique to communications systems and not included in Division 26 sections.

B. Refer to Section 27 0000 – General Communications Requirements and 26 0529 - Hangers and Supports for Electrical Systems - Part 1 for requirements for Reference Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee.

1.2 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0528.33 - Raceway and Boxes for Communications Systems
3. Section 27 0528.36 - Cable Tray for Communications Systems
4. Section 27 1000 - Structured Cabling
5. Section 27 1100 - Communications Equipment Room Fittings
6. Section 27 1300 - Communications Backbone Cabling
7. Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Section 26 0529 - Hangers and Supports for Electrical Systems

1.3 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for:

1. Hanger Rods
2. Beam Clamps
3. Wall Anchors
4. Metal Framing

2.2 J-TYPE CABLE SUPPORT HOOKS

A. Cable support hooks shall be a wide-base type for use in a non-continuous pathway.

B. Hook material shall be Galvanized metal or Nylon for smooth cable pull and corrosion resistance.

1. Hook may be coated to reduce cable friction.
2. Hook material shall be rigid. Flexible material not allowed.

C. Hooks shall:

1. Comply with UL, cUL, NEC and EIA/TIA requirements for structured cabling systems.
2. Be designed to limit cable bending per cable manufacturers' recommendations.
3. Be capable of being installed in a single- or multiple-hook ("tree") configuration.
4. Incorporate a latch or other mechanism to retain cable.

PART 3 - EXECUTION

3.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 3 for all products identified in Part 1.

3.2 J-TYPE CABLE SUPPORT HOOKS

A. Where installed free-air above suspended ceiling or below raised floor, support cables using J-hook type cable supports installed in accordance with manufacturer's installation requirements.

B. Support hooks from structure. Do not support from ceiling grid, conduit or other trades work.

C. Space J-hook cable supports every 4 ft or in accordance with cable manufacturer's specifications, whichever distance is shorter.

D. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.

END OF SECTION 270528.29

SECTION 270528.33 - RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

1.2 DESCRIPTION

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:

1. Outlet Boxes
2. Pull and Junction Boxes
3. Raceways and Wireways (including sleeves, expansion fittings, penetrations and seals)
4. Indoor Service Poles
5. Poke-through Fittings
6. Floor Boxes
7. Cable Supports

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.36 - Cable Tray for Communications Systems
5. Section 27 0553 - Communications Systems Identification
6. Section 27 1000 - Structured Cabling
7. Section 27 1100 - Communications Equipment Room Fittings
8. Section 27 1300 - Communications Backbone Cabling
9. Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Section 26 0533 - Raceway and Boxes for Electrical Systems

1.4 REFERENCES AND STANDARDS

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 2 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

2.2 COMMUNICATIONS RACEWAYS

A. OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY (INNERDUCT)

1. UL 2024; flexible type, approved for plenum, riser, general purpose and flame-retardant installation

2. Outdoor Innerduct: Smooth outside and ribbed inside
3. Indoor Innerduct: Corrugated
4. Color:
   a. General Purpose: Orange
   b. Flame-retardant: Orange
   c. Riser: Orange
   d. Plenum: Orange

5. Manufacturers: Carlon; Pyramid; Approved equal

PART 3 - EXECUTION

3.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 3 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

3.2 COMMUNICATIONS RACEWAYS

A. Optical Fiber Communications Cable Raceway (Innerduct):

1. Minimum innerduct size: 1”, unless otherwise noted on drawings.

2. Extend innerduct to termination and/or storage enclosure.
3. Provide couplings designed for innerduct size and type where innerduct enters a termination and/or storage enclosure.
4. Splice innerduct segments using couplings designed for that purpose, where not installed in a continuous length.
5. Provide 200 lb nylon pull cord in empty innerduct. Leave at least 12” of slack at each end of pull wire. Cap innerduct at both ends.
6. Label innerduct with tags indicating cable type and cables contained therein.

a. Label in each maintenance hole, pull box and communications equipment room, where exiting a conduit and at 10 ft intervals in cable tray or where otherwise exposed.

3.3 MULTI-CELL FLEXIBLE RACEWAY

A. Segment conduits to increase capacity.

1. Provide quantity and size per project Drawings.

B. Install per manufacturers recommendations.

END OF SECTION 270528.33

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SECTION 270528.36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems.
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 1000 - Structured Cabling
6. Section 27 1100 - Communications Equipment Room Fittings
7. Section 27 1300 - Communications Backbone Cabling
8. Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Section 26 0526 - Grounding and Bonding for Electrical Systems
2. Section 26 0529 - Hangers and Supports for Electrical Systems
3. Section 26 0533 - Raceway and Boxes for Electrical Systems
4. Section 26 0536 - Cable Trays for Electrical Systems
5. Section 26 0593 - Electrical System Firestopping

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Provide complete cable tray system including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations as indicated on drawings.

B. Cable tray system is intended to carry communications cable only. Fire alarm system and overhead page cables are not allowed.

1.4 REFERENCE STANDARDS

A. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and forged Steel Shapes, Plates, Bars, and Strip.

B. ASTM A 446 - Specification for Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality.

C. ASTM A 525 - Specification for Steel Sheet, Zinc-Coated Galvanized by Hot Dip Process.

D. ASTM A 607 - Specification for Steel Sheet and Strip, Hot-rolled and Cold-Rolled, High Strength, Low Alloy Columbium or Vanadium.

E. ASTM B 633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

F. NEMA VE 1 - Metal Cable Tray Systems.

G. NEMA VE 2 - Cable Tray Installation Guidelines

H. BICSI - Telecommunications Distribution Methods Manual (TDMM)

1.5 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. Submit as-built drawings showing floor plan locations, elevation changes, and conduit drops.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers

1. Cooper B-Line (FLEXTRAY™)
2. Chalfant Cable Trays
3. Mono-Systems (Mono-Mesh™)
4. MP Husky
5. Legrand (CABLOFIL®)

2.2 MATERIALS AND FABRICATION

A. Materials of Construction:

1. Materials shall be adequately protected against corrosion or made of corrosion resistant material.

B. Wire Mesh Trays

1. Tray shall be continuous, rigid, welded steel wire mesh cable management system.
2. Maximum mesh dimension shall be 2 x 4 inches (50 x 100 mm).
3. Material shall be carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture
4. Finish shall be Electro-Plated Zinc Galvanizing per ASTM B 633, Type III, SC 1 or Electro-plated yellow zinc dichromate in accordance with ASTM B 633, Type III, SC 2.
5. Dimensions:
   a. Inside width: As indicated on Project Drawings

b. Loading depth (NEMA VE 1): 4" minimum

6. Tray system shall not present sharp edges, burrs or projections injurious to wiring.
7. Hardware, including splice connectors and support components, shall be furnished by tray manufacturer.
8. Tray shall be UL classified for use as an equipment grounding conductor.
9. Tray shall be designed to support volume capacity of cables and provide safe mechanical support for spans up to 8 feet (2.4 meters) on center. Tested load deflection data is available either in accordance with NEMA VE 1 or IEC 61537 standards
10. Splice plates shall be the bolted type made specifically for tray type provided.
    a. Splice plate construction shall be designed to permit splice to be located at any point within support span without diminishing cable tray rated loading capacity.

2.3 SUPPORT SYSTEM

A. Supports shall comply with product requirements defined in specification section 26 0529 - Hangers and Supports for Electrical Systems.

B. Flexible cordage/wire shall not be used.

2.4 ACCESSORIES

A. Special accessories shall be furnished as required to protect, support, and install cable tray system.

1. Accessories include section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts and barriers.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide complete cable tray system, including straight tray sections, fittings, splice plates, and cable tray supports to support cable systems in locations, as indicated on drawings.

B. Comply with manufacturer’s recommended installation practices in addition to applicable standards and codes.

C. Completed installation shall present smooth surfaces and rounded edges with no burrs, projections or sharp edges that may prove injurious to installed wiring.

3.2 WIRE MESH

A. Cut wires in accordance with manufacturer's instructions.

B. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.

C. Cut each wire with one clean cut to eliminate grinding or touch-up.

3.3 INSTALLATION

A. Install metallic cable tray in accordance with NEMA VE 1 and VE 2.

B. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, connectors, and grounding straps as required.

C. Provide blind end plates for trays that dead end.

D. Provide full-width dropouts (4" minimum bend radius) where cables exit from tray bottom.

E. Join cable tray system sections at ends using manufacturer prefabricated splice plates.

1. No more than one cable tray splice shall be placed between support spans.

F. Tray system shall be accessible, with sufficient space provided about cable trays to permit side and top access for installation and maintenance of cables.

1. Coordinate installation of cable tray to maintain clearance between cable tray and other trades work.
2. Clearance shall be minimum 18" on at least one side, 12" on top and 6" below cable tray.
3. Tray shall not restrict removal of ceiling panels or lighting assemblies.
4. Notify Engineer for clarification and direction before proceeding with installation if access conditions cannot be met.

G. Do not install cable tray below re-heat coils, VAV boxes, traps, or other building components that require access from below.

H. Refer to specification section 27 1000 - Structured Cabling for separation requirements from potential EMI sources.

I. Provide prefabricated expansion splice plates at intervals as defined in NEMA VE 2 and where cable tray systems cross building expansion joints.

J. Provide minimum of 1 expansion splice plate in straight runs which exceed 12 ft for tray installations in exterior areas.

K. Field fabricate fittings in accordance with manufacturer’s instructions.

1. Minimum inside radius of fittings shall approximate 12-inch radius available using ladder-type cable tray.

L. Where cable tray would penetrate fire rated wall, stop tray at wall and fasten tray end to wall.

1. Provide (1) 4" sleeve, threaded at both ends, through wall for every 4" of tray width.
2. Sleeves shall extend minimum of 4" beyond both sides of fire rated wall and final assembly shall carry UL listing to maintain fire and smoke rating of wall penetrated.
3. Provide plastic bushings on both ends of each sleeve.

4. Provide UL listed grounding connectors and conductors to extend cable tray grounding path through sleeved wall penetration.

M. Where cable tray distribution system encounters inaccessible ceiling area, provide sufficient 4" EMT sleeves/conduit through area to maintain maximum of 40% cable fill ratio.

N. Provide bolts and nuts in all holes of cable tray fittings per manufacturer's installation instructions.

O. Cable tray systems shall be electrically continuous.

P. Nicks and scratches and ends of cut sections with galvanized coatings shall be coated, with approved coating that matches cable tray finish, after tray installation.

3.4 SUPPORT

A. Support cable tray system utilizing trapeze hangers from building or other structural steel members, angle brackets from vertical structural steel members, upright angle brackets on pipe racks, or directly upon horizontal structural steel members of the building or pipe racks.

1. Center run hangers are not allowed.
2. Cable tray may be wall mounted only in cases where trapeze mounting from above is not possible due to obstructions. Contractor shall review such situations with Engineer for approval prior to installation.

B. Supports shall be constructed from formed shape channel members 1.625" x 1.625", pre-galvanized 14 Ga. steel complete with nuts, bolts, washers, lock washers and tray clamps as required for complete and finished installation.

1. Where formed mounting assemblies are part of manufacturer's integrated cable tray system, these may be used in compliance with manufacturers recommended practices.

C. Threaded rod used for tray support shall be 3/8" minimum diameter.

D. Size, anchor, and space supports to sustain weight of cable tray system, cable, and tubes that are to be installed into cable tray, and 200 lbs excess on any individual section, with safety factor of 1.5 minimum when supported as simple span and tested per NEMA requirements. Load and safety factors are applicable to all tray components.

E. Calculate supports based on 60 lbs/ft load of cables and tubes. Support spans shall not exceed manufacturer's recommendations.

F. Total vertical tray deflection shall not exceed 1-1/2" between supports when tray is loaded to capacity.

G. Include dynamic loads in calculations for outside area installations.

H. Maximum allowable deviation of tray, from level horizontal plane measured across width of tray, is one half of one inch (1/2") with tray loaded to capacity.

1. Approval of installation method does not relieve contractor from meeting above deviation requirement. If additional support is needed, as determined by project engineer, contractor shall provide additional support at no additional cost

3.5 GROUNDING

A. Cable tray systems shall be electrically continuous.

1. Bonding Jumpers shall be used between discontinuous tray sections as called for in manufacturer's installation guidelines to maintain grounding continuity of cable tray system.
2. Grounding connections to tray shall be made using a UL listed mechanical connection.

B. Connect each cable tray system subassembly to building ground system using grounding clamps and grounding conductors. Provide 3.0 ohm maximum resistance to building ground connection.

C. Cable tray shall not be connected to instrumentation grounding system.

D. Bond conduits to cable tray as defined by NEC references in NEMA VE-1 and VE-2.

END OF SECTION 270528.36

SECTION 270553 - COMMUNICATIONS SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for labeling of communications cabling, termination components, pathways and spaces for Communications Systems.

1.2 DESCRIPTION

A. All components shall be clearly labeled to identify them as unique throughout the project.

B. Labeling requirements include identification of Rooms, Equipment Racks, Telecommunications Outlets, Horizontal and Backbone Cabling, Termination Hardware (Patch Panels, Blocks) and Grounding.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 1000 - Structured Cabling
4. Section 27 1100 - Communications Equipment Room Fittings
5. Section 27 1300 - Communications Backbone Cabling
6. Section 27 1500 - Communications Horizontal Cabling
7. Section 27 5113 – Overhead Paging

B. Related Division 28 Sections include:

1. Section 28 1000 – Electronic Access Control
2. Section 28 2300 – Video Surveillance

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

1. TIA/EIA-606-A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product and/or installation information to be submitted by contractor.

B. Prior to installation, provide samples of label types planned for the project.

1. Samples shall include examples of lettering to be used and shall follow standards detailed below.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements which identifies general quality assurance requirements for the project.

PART 2 - PRODUCTS

2.1 GENERAL

A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.

B. Cable labels shall be self-laminating, White/Transparent Vinyl (or other substrates facilitating easy application and flex as cables are bent) and incorporate an integrated clear lamination which covers printed part of label when label is wrapped around cable.

1. If cable jacket is white, provide cable label with printing area that is a color other than white to easily distinguish label from cable jacket.
2. Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.

3. Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.

C. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing. Tags shall be non-removable.

1. Exceptions:
   a. Telecommunications Outlet labels that are placed in recessed label holders.
   b. Telecommunications Ground tags secured with cable ties.
   c. Innerduct Tags secured with cable ties.

D. Labels for 110-type Termination Blocks shall be Color-coded to indicate the cable type (inter-building, intra-building backbone, horizontal, etc.). Refer to Part 3.

PART 3 - EXECUTION

3.1 GENERAL

A. Labeling shall be by mechanical means.

1. Hand lettered designations are not allowed.

B. Tags shall be non-removable.

1. Exceptions:
   a. Telecommunications Outlet labels that are placed in recessed label holders.
   b. Telecommunications Ground tags secured with cable ties.
   c. Innerduct Tags secured with cable ties.

C. Characters shall be Black Ink and printed on background of contrasting color.

D. Labels shall match hardware layout and design.

E. Labels shall be as large as practicable while fitting properly.

F. No lettering shall be smaller than 10-point.

G. Label cables with tag which is wrapped around cable sheath.

1. Clean cable sheath thoroughly before applying label.
2. Labels shall not be obscured by termination hardware.

3.2 ROOM IDENTIFICATION

A. Label Communications Backboard or Equipment Rack closest to entry door with unique identifying code.

B. Characters shall be 1”minimum.

3.3 EQUIPMENT RACK IDENTIFICATION

A. Label each Equipment Rack with unique identifying code as follows:

1. TR-##, where:
   a. "TR" is identifier for room where rack is located
   b. "##" is sequential number for rack starting at "01".

B. Position Labels at top of rack.

C. Characters shall be 1-inch minimum.

3.4 TELECOMMUNICATIONS OUTLET

A. Label each Telecommunications Outlet (TO) connector with unique identifying code.

B. Telecommunications Outlet connector numbering shall result in logical numbering sequence in work area.

1. Labeling plans that results in random TO numbering in work area are not acceptable.

C. Place Faceplate labels on outside of cover.

D. Position Labels in recessed label holders on faceplate and covered with clear plastic covers.

1. Where Communications Outlet Faceplates not incorporating recessed holders are allowed, faceplate labels shall be protected with clear laminate.

E. Telecommunications Outlet labeling code shall be as follows:

1. TR-RPP-##, where:
   a. “TR” is identifier for room where cable terminates in horizontal cross-connect.
   b. “R” is identifier for Equipment Rack where cable terminates
      1). Alpha character starting at “A”.
   c. "PP" is Patch Panel on which cable is terminated at HC.
      1). Number starting at “01”.
      2). Panel numbering shall be from Top (of Rack) to Bottom.
   d. "##" is sequential POSITION of Jack on Panel
      1). 1 - 48 is typical
      2). Position sequence shall be Left-Right and Top-Bottom.

2. Example: "3W-A03-25" represents 25th Jack Position in 3rd Panel on Equipment Rack “A” in Telecom Room "3W".
   a. Faceplate labels can use common TR identifiers on each label strip. For example, two data jacks served from TR 3W sharing common label strip may be represented by:

3W	
A01-25	A01-26

1. TR-Y-ZZZ, where:
   a. TR = Identifier for room where cable terminates in horizontal cross-connect.

b. Y = Cable type (V = Voice, D = Data, F = Fiber Optic, T = CATV coax)
c. ZZZ = Jack # (001,002, etc.)

2. Faceplate labels can use common room number designations on each label strip. For example, one voice and one data jack served from TR 3W sharing common label strip may be represented by:

3W	
D-101	V-101

3.5 HORIZONTAL CABLING

A. Label each horizontal cable at Telecommunications Outlet and at horizontal cross-connect with unique identifying code.

B. Cable shall be labeled at both ends within 4" of cable choke (end of jacket).

C. Horizontal labeling code shall be same as identified for Telecommunications Outlet above.

3.6 MODULAR PATCH PANEL

A. Label each patch panel and port at horizontal cross-connect with unique identifying code.

B. Patch panel labeling code shall be same as identified for Telecommunications Outlet above.

C. Room number is not required on modular patch panels.

D. Equipment Rack number is not required on modular patch panels.

3.7 BACKBONE COPPER CABLE

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label cable sheath:

1. At point where sheath ends
2. At point on cable where viewing of label is not obscured by termination blocks or other visual barrier.

C. Label shall be on plastic tag tie-wrapped to cable sheath, or placed on adhesive labels adhered to cable sheath.

1. If adhesive labels are used, place clear plastic tape over label to protect it and maintain adhesion to sheath.

D. Label Intra-building cables with:

1. From and to locations,
2. Pair numbers

a. Where multiple cables are installed between same end-points, labeling shall indicate sequential pair numbering.
   1). For example 400-pair provided as two 200-pair cables would be labeled "001-200" and "201-400".

3. Date installed.
   a. Example 200-pair cable from ER106 to TR3164 installed October 2009:

ER106-TR3164
001-200
10/2009

E. Label Inter-building (between buildings) cables with:

1. From and to locations,
2. Pair numbers
   a. Where multiple cable is installed between same end-points, labeling shall indicate sequential pair numbering.
      1). For example 400-pair provided as two 200-pair cables would be labeled "001-200" and "201-400".

3. Date installed.
   a. Example 600-pair Cable from Building 108 ER to Building 110 ER installed October 2009:

ER180-ER110
001-600
10/2009

3.8 TERMINATION BLOCKS

A. Provide color-coded designation strips with Termination Blocks.

B. Label termination positions on designation strips with position identifier.

C. Horizontal Cabling Blocks shall incorporate BLUE Designation Strips and shall identify:

1. Telecommunications Outlet / Jack I.D.s

D. Intra-Building (within building) Backbone Cabling Blocks shall incorporate WHITE Designation Strips.

1. Label Designation Strips with:
   a. Cable Origin & Destination
      1). Repeat on every designation strip.
   b. Pair Count.
      1). Label 1st and 25th Positions on each row (e.g. 001 & 025, 026 & 050, etc.).

2. Example ER106 to TR3164:

001	ER106-TR3164	025
026	ER106-TR3164	050

E. Inter-Building (between buildings) Backbone Cabling Blocks shall incorporate BROWN Designation Strips.

1. Label Designation Strips with:
   a. Cable Origin & Destination
      1). Repeat on every designation strip.
   b. Pair Count
      1). Label 1st and 25th Positions on each row (e.g. 001 and 025, 026 and 050, etc.).

2. Example cable linking Building 123 ER and Bldg. 456ER:

001	123ER-456ER	025
026	123ER-456ER	050

F. Voice "Multiplier" Blocks shall incorporate YELLOW Designation Strips.

1. Label each designation strip with "Multiplier"
2. Label 25-pair rows in 100-pair multiplier block as "A" (1st 25-pair). "B" (2nd 25-pair), "C" and "D".
3. Label Pair Count
   a. Label 1st Block 001 - 025; label 2nd Block 025 - 050, etc.
   b. Label 1st and 25th Positions on each row (e.g. 001 and 025, 026 and 050, etc.).

4. Example:

A001	MULTIPLIER	A025
B001	MULTIPLIER	B025

C001	MULTIPLIER	C025
D001	MULTIPLIER	D025

G. Feed Blocks (from Access/Service Provider) shall incorporate GREEN Designation Strips.

1. Label Designation Strips with:
   a. Designation as "FEED CABLE"
   b. Pair Count.

2. Example (Verizon as Service Provider):

1201	FEED (VERIZON)	1225
1226	FEED (VERIZON)	1250

H. Telephone system Equipment Blocks shall incorporate PURPLE Designation Strips.

1. Label Designation Strips with:
   a. Designation (e.g. System or Equipment Type)
   b. Pair Count.

2. Example (PBX):

001	PBX	025
026	PBX	050

3.9 BACKBONE FIBER OPTIC CABLING

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label shall be placed on adhesive labels adhered to cable sheath.

C. Label Intra-building cables with:

1. From and to locations,
2. Fiber type (core/cladding diameter)
3. Fiber count
   a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
      1). For example 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".

4. Date installed.
5. Example 72-fiber cable from ER106 to TR3164 installed October 2009:

ER106-TR3164
50/125 001-072
10/2009

D. Label Inter-building cables with:

1. From and to locations,
2. Fiber type (core/cladding diameter)
3. Fiber count
   a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
      1). For example 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".

4. Date installed.
5. Example 72-fiber cable from Building 108 ER to Building 110 ER installed October 2009:

ER108-ER110
50/125 001-072
10/2009

3.10 FIBER OPTIC PATCH PANELS

A. Label each fiber coupling in patch panel or workstation outlet with unique identifying code.

B. Patch panel labels shall be visible from front of panel without opening panel cover.

C. Place labels in manufacturer designated labeling areas.

D. Label Fiber Optic Patch Panels with unique labeling code to identify:

1. Cable Destination
2. Fiber type (core/cladding diameter)
3. Fiber (or coupler) number of each panel position.
   a. Port I.D. shall be from Top to Bottom, Left to Right,
   b. Manufacturers port labeling is acceptable.

E. Label Fiber Optic Patch Panels with unique labeling code to identify:

1. Patch panel number in rack
2. Fiber (or coupler) number of each panel position.
   a. Port I.D. shall be from Top to Bottom, Left to Right,
   b. Manufacturers port labeling is acceptable.

F. Room number is not required on fiber optic patch panels.

G. Equipment Rack number is not required on fiber optic patch panels.

3.11 INNERDUCT

A. Innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

1. Includes areas where innerduct is installed in trays and in equipment rooms.

B. Label innerduct with durable Yellow Polyethylene tag that reads "CAUTION FIBER OPTIC CABLE"

1. Tag shall provide blank spaces for adding fiber count and cable destination information.

C. Label Tag to include:

1. Identifier(s) of cable(s) contained therein.
   a. Use Backbone Cable labeling formats as described above.

D. Hand lettering is acceptable on tag

1. Use an indelible type ink.

E. Tag shall be secured to Innerduct using self-locking ties.

3.12 TELECOMMUNICATIONS GROUNDS

A. Label Grounds as close as practicable to point of termination.

B. Labels shall be non-metallic and include the following:

WARNING IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.

END OF SECTION 270553

SECTION 271000 - STRUCTURED CABLING

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Structured Cabling for Communications Systems.

1.2 DESCRIPTION

A. Systems shall include cabling, termination hardware and active components, installed as indicated on drawings and specifications.

B. Cables and equipment shall be provided, tested, and terminated, including proper grounding and bonding.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 0528.36 - Cable Tray for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1100 - Communications Equipment Room Fittings
8. Section 27 1300 - Communications Backbone Cabling
9. Section 27 1500 - Communications Horizontal Cabling
10. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

B. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition:

1. TIA 568-C.0 through C.3 - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
2. TIA 569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
3. BICSI Telecommunications Distribution Methods Manual (TDMM)
4. TIA-758 - Customer-Owned Outside Plant Telecommunications Cabling Standard

5. TIA-598-C: Optical Fiber Cable Color Coding.
6. TIA 455-21-A: Mating Durability for Fiber Optic Interconnecting Devices
7. TIA 526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
8. TIA-526-7: Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant
9. UL-910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
10. UL-1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
11. IEEE 802.3af and 802.3at Power-over-Ethernet Standards.
12. IEEE 802.3an 10 Gigabit Standard

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction:

1. Backbone Cabling - cable or conductors between telecommunications rooms, or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings. Backbone cabling may be twisted pair copper, fiber optic or coaxial.
2. Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
3. Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
4. Channel - end-to-end transmission path to which application-specific equipment is connected. Same as "Permanent Link", but also includes patch cords at Telecommunications Outlet and in Telecom Room.
5. Consolidation Point (CP): A location for interconnection between horizontal cables extending from the horizontal cross-connect and horizontal cables extending to the telecommunication outlet at the workstation.
6. Contractor: Telecommunications Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of communications cabling, termination components, pathway hardware, telecommunications equipment room hardware and related components detailed in technical sections of this Division of work.
7. Cross-Connect - group of connection points between cabling runs and/or equipment used to administer building wiring using patch cords or wire jumpers.
8. Horizontal Cabling - Cables connecting Telecommunications Outlets to horizontal or intermediate cross-connect. Sometimes referred to as "Station Cabling".
9. Horizontal Cross-connect (HC) – Connection of horizontal cabling to other cabling (e.g. horizontal, backbone or equipment) using patch cords or wire jumpers.
10. Interconnection - Connection scheme using connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper
11. Main Cross-connect (MC) – Connection between backbone cables, entrance cables and equipment cables using patch cords or wire jumpers.
12. Outlet ID - unique alpha-numeric identification used for referencing Telecommunications Outlet or connectors therein.
13. Permanent (Cable) Link - includes Telecommunications Outlet, horizontal (station) cable and termination hardware in Telecom Room.
14. Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.

15. Telecommunications Outlet (TO) - device assembly located in work area on which horizontal cabling terminates and which can receive modular connectors. It is interface between Station Cable and end user's equipment.
16. Telecom Room - an enclosed space for housing telecommunications equipment, horizontal and backbone cable terminations, and cross-connect cabling, that is recognized location of horizontal cross-connect.
17. Zone Box - An enclosure used to house one or more of the following; a) a consolidation point, b) a horizontal connection point, c) building automation system outlets.
18. Zone Cabling - Extends permanent horizontal cabling to a shared termination (consolidation) point in the work area. Passive system extends link to workstation through at interconnect at the Consolidation Point (CP). Active system includes system electronics at the CP.

C. “10-gigabit” or “10G” performance criteria, if applicable, refers to support of 10GBASE-T application over 4-connector channel up to 100 meters and meeting requirements of TIA-568-C.2.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction:

1. 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
2. CM Communications cable rated for General Purpose use
3. CMP Communications cable rated for use in Plenum areas
4. CMR Communications cable rated for use in Risers and vertical runs
5. CP Consolidation Point
6. ELFEXT Equal-Level Far-End Cross Talk (pair-to-pair)
7. FEXT Far-End Cross Talk
8. F/UTP Foiled Unshielded Twisted Pair

   No shielding around individual pairs and an overall foil shield under the cable jacket

9. HC Horizontal Cross-connect
10. HCP Horizontal Connection Point (e.g. for TIA-862)
11. IDF Intermediate Distribution Frame
12. MC Main Cross-connect
13. MDF Main Distribution Frame
14. N Newton
15. NEXT Near End Cross Talk
16. OFNP Optical Fiber Nonconductive Plenum
17. OFNR Optical Fiber Nonconductive Riser
18. OTDR Optical Time Domain Reflectometer
19. PBX Private Branch Exchange (Telephone Switch)
20. PoE Power-over-Ethernet
21. PSNEXT Power Sum Near End Cross Talk
22. S/FTP Screened Foiled Twisted Pair

    (Individual foil shield around each individual pair and an overall braided shield under the cable jacket.)

23. S/UTP Screened Unshielded Twisted Pair
    (No shielding around individual pairs and an overall braided shield under the cable jacket.)

24. SF/UTP Screened Foiled Unshielded Twisted Pair
    (No shielding around individual pairs and overall foil and braided shields under the cable jacket.)

25. TO Telecommunications Outlet
26. TR Telecommunications Room
27. USOC Universal Service Order Code
28. UTP Unshielded Twisted Pair
    (No shielding around pairs nor overall under cable jacket.)

29. U/FTP Unshielded Foiled Twisted Pair
    (Individual foil shield around each individual pair and no overall braided shield under the cable jacket.)

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. In addition, Submit:

1. Contractor Certification documents which document their participation in Installers Program operated by Manufacturer of Cabling or Termination Components used.
   a. Upon request, Certified Installer(s) assigned to Project shall be identified to Engineer.

1.9 QUALITY ASSURANCE

A. General:

1. Cable and Equipment Manufacturer(s) shall be company specializing in communications cable, accessories and/or equipment with minimum of 5 years documented experience in producing cable, accessories and/or equipment similar to those specified herein.

B. Contractor Qualifications:

1. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete cable and equipment installation and termination.
2. Contractor shall have been in this business for minimum of 5 years and shall have successfully completed 4 projects equal in magnitude of system specified in the following sections.

C. Contractor shall have necessary certifications to provide for Warranty as specified herein.

1. Contractor shall be an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used.
   a. Contractor shall be participant in this program at time of Bidding and remain so throughout project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents and Section 27 0000 - General Communications Requirements for general guarantee requirements.

B. Warranty structured cable system as follows:

1. 4-pair Category-rated Horizontal Copper Permanent Link for no-less than 20 years from date of substantial completion of work.
2. Copper Backbone for no-less than 2 years from date of substantial completion of work. Cabling and Connecting Components shall carry 20 yr component warranty.
3. Fiber Optic Backbone for no-less than 20 years from date of substantial completion of work.

C. Warranty shall be direct from manufacturer(s) of cabling and connecting components to Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to individual Technical Sections.

2.2 POWER OVER ETHERNET

A. All cable and connecting components that comprise the TIA horizontal cabling “Permanent Link” from Horizontal Cross-connect to Telecommunications Outlet shall be compliant with the applicable requirements for “DTE Power via the MDI” to provide at least 25.5W at the Powered Device as defined by the IEEE 802.3at standard.

B. Connecting hardware shall comply with IEC 60512-99-001 for engaging and separating connectors under electrical load and connectors used in twisted pair communication cabling with remote power.

2.3 SYSTEM REQUIREMENTS

A. Structured cabling products shall be designed to work together as a fully-warranted system.

B. Acceptable Category 6 systems shall be:

1. CommScope SYSTIMAX GigaSPEED XL
2. Siemon Premium 6 Z-MAX
3. PanGen (Panduit/General Cable) Category 6 System Solutions Premium

4. Berk-tek Leviton Technologies CX6150 CAT6 Enhanced System
5. nCompass (Superior Essex/Ortronics) CAT6E+ System
6. Approved Equivalent

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to individual technical specification sections for detailed Cable Routing and Installation, Testing and Documentation requirements. The following apply to communications cabling and termination work.

B. Installation shall be per manufacturers' recommendations.

C. Label cables and termination components per Section 27 0553 - Communications Systems Identification.

3.2 CABLE INSTALLATION

A. Run cabling in raceways provided, or as designated on floor plans, and support from building structure.

1. Where installed in free-air, support cables using J-hook type cable supports installed in accordance with manufacturer's installation requirements. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.
   a. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
   b. Route cable/hooks at right angles, parallel to construction.

2. Where installed in Cable Tray, lay cables neatly in tray.
   a. Do not tie.
   b. Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.

B. Route and support cable in Equipment Rooms and Telecom Rooms utilizing "D-type" mounting rings, J-hooks and overhead cable runway.

C. Cable shall be free of tension at both ends.

1. In cases where cable must bear stress, provide Kellems grips to spread stress over longer length of cable.

D. Provide required installation tools to facilitate cable pulling without damage to cable jacket.

E. Keep cables clear of other trades work.

F. During pulling operation provide an adequate number of workers to allow cable observation at points of raceway entry and exit, as well as to feed cable and operate pulling machinery.

G. Pull cables in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 Standards.

H. Pull cable by hand unless installation conditions require mechanical assistance.

I. Do not exceed recommended pulling tensions and bending radii.

1. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.
   a. This may be in form of continuous monitoring of pulling tension, use of "break-away" or other approved method.

2. Replace cables bent or kinked to radius less than recommended dimension.
   a. This shall be at no expense to Owner.

J. Install cables splice-free unless otherwise specified.

K. Avoid abrasion and other damage to cables during installation.

1. Visually inspect cables for cuts, blisters and abrasions during installation.

L. Pulling lubricant may be used and shall:

1. Be non-injurious to cable jacket and other materials used.
2. Not harden or become adhesive with age.

M. Repair damage to interior spaces caused by installation of cable, raceway or other hardware. Repairs must match preexisting color and finish of walls, floors and ceilings.

N. Replace contractor-damaged ceiling tiles to match color, size, style and texture.

O. Provide pull cord (200 lb minimum) with cable installed in conduit or innerduct.

P. Neatly lace, dress and support cabling.

Q. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.

1. Strap vertical runs as required, to prevent sagging of cables.

R. To reduce effects of EMI, adhere to the minimum cable separation distances defined in TIA-569-C.

3.3 FIELD TESTING

A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performing compliance testing.

B. Cabling shall be 100% fault free unless otherwise noted. If any Link is found to be outside specification defined herein, identify and correct problem up to and including replacement of cable and associated termination(s). Then repeat applicable tests.

C. Test each cabling sub-system (e.g. backbone, horizontal, etc.) end-to-end.

D. Where sub-systems are to be interconnected or cross-connected by the contractor, test individual sub-system followed by a test of the connected links

1. Performance and documentation requirements shall default to the lesser of the two connected systems if different.
2. Example 1: Combined Backbone-Horizontal Link
   a. Test and document individual Backbone and Horizontal Cabling Sub-systems.
   b. Cross-connect sub-systems.
   c. Repeat testing on combined cabling from MC - TO through HC.
   d. Performance and documentation requirements shall be based in this example on backbone cabling (continuity, pair integrity, etc.).

3. Example 2: Interconnected Zone Cabling Link
   a. Test and document individual HC – CP links.
   b. Install interconnect cabling CP – TO
   c. Repeat testing on combined cabling from HC – TO through CP.
   d. Performance and documentation requirements shall be based in this example on TIA Permanent Link for Horizontal Cabling.

E. Test instrument shall be configured using template for exact cable under test (e.g. by manufacturer product designation).

1. If no template is available, enter cable parameters for the cable per manufacturer's product data.
   a. Nominal Velocity of Propagation (NVP) used for copper cable type under test shall be traceable to manufacturers' product data.
   b. Refractive Index used for fiber optic cable type under test shall be traceable to manufacturers' product data.

2. Test results obtained using incorrect cable parameters will be rejected.

F. Test instrument shall be calibrated as defined by instrument manufacturer at least once every 12 months.

1. Test instrument calibration date shall be present in test results documentation.

G. Refer to individual Technical Sections for system-specific guidelines regarding requirements for scheduling and performing compliance testing.

3.4 DOCUMENTATION

A. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for project Documentation.

B. Refer to individual Technical Sections for system-specific guidelines regarding requirements for project Documentation.

C. Information added by Contractor to Record Drawings shall include:

1. Backbone and horizontal cable routes
2. Telecommunications outlet locations and identification
3. Other detail necessary to document cable installation

3.5 OWNER TRAINING

A. Provide training for Owner's personnel on operation and maintenance of total system and each component.

B. Training to include:

1. Overview of System Topology and General Concepts
2. Overview of Product Used
3. Overview of Equipment Room Layouts
4. Overview of Labeling Formats
5. Overview of Test Results and their meaning
6. Overview of Documentation

C. Training shall be held at Project Site and shall be conducted during normal working hours.

D. Training session duration shall be not less than one (1) h.

1. Provide (1) such sessions.
2. Coordinate with owner to schedule session(s). Provide adequate notification to allow owner to schedule staff.

E. Attendance shall be by owner staff.

1. Number of Students per session shall be determine by owner.
2. Materials shall be provided for the number of students indicated.

F. Provide example course materials and instructor background in advance of training session(s).

G. Owner may videotape session(s) for use as future refresher materials for owner technical staff.

END OF SECTION 271000

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SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Communications Equipment Room Fittings for Communications Systems.

1.2 DESCRIPTION

A. Communications Equipment Room Fittings include:

1. Cabinets, Racks, Frames and Enclosures
2. Cable Runway
3. Termination Blocks
4. Patch Panels
5. Entrance Protection
6. Power Strip/Surge Suppressor

B. Refer to Project Drawings for Equipment Room layout and equipment placement.

1.3 RELATED WORK

A. Refer to Section 27 0000 - General Communications Requirements which identifies related specification sections in this and other Divisions (if applicable).

1.4 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 0528.36 - Cable Tray for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1000 - Structured Cabling
8. Section 27 1300 - Communications Backbone Cabling
9. Section 27 1500 - Communications Horizontal Cabling
10. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

C. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 - PRODUCTS

2.1 CABINETS, RACKS, FRAMES AND ENCLOSURES

A. Manufacturers: Rittal, CPI, Ortronics, Wrightline, Panduit, Damac or Siemon

B. Equipment racks shall be:

1. Constructed of painted aluminum
2. Color Black
3. Supplied with ground bar (19” wide by 1” high) and #6 AWG ground lugs
4. Supplied with minimum of 12 releasable cable support ties (e.g. "hook and loop")
5. Supplied with spare screws (minimum of 50)
6. Configured with Channel uprights spaced to accommodate industry standard 19” mounting

C. Free Standing Equipment Rack shall comply with general requirements above and shall:

1. Be 84” in height
   a. Have minimum of 45 usable rack mounting units (RU)

2. Be self-supporting
3. Have Minimum base footprint of 15” x 20”
4. Be double-sided drilled and tapped to accept 12-24 screws
   a. Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
   b. Hole pattern on rack front and back shall be per EIA/TIA specifications (5/8” – 5/8” – 1/2”).

D. Wall Mounted Equipment Cabinet shall comply with general requirements above and shall:

1. Be 48” in height
   a. Have minimum 26 usable rack mounting units (RU)

2. Be minimum 24” deep from front face of vertical rails to wall behind
3. Be double-side drilled and tapped to accept 12-24 screws
   a. Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
   b. Hole pattern on rack front and back shall be 5/8” – 5/8” – 1/2”.

E. Cable Management

1. Manufacturers: Rittal, CPI, Wrightline, CommScope, Ortronics, Panduit or Siemon
2. Horizontal Cable Management Panels shall:
   a. Be painted steel
   b. Be 3.5” high
   c. Have minimum of 5 distribution rings (3.75” x 3.75” minimum dimension)
      1). Distribution rings shall be plastic**.**
   d. Incorporate cable routing guides and supports on rear of panel.

3. Vertical Cable Management shall:
   a. Provide for cable routing on front and rear of each rack
   b. Be 8” wide (minimum) when installed between two racks
   c. Be 6” wide when installed at end of rack row
   d. Mount on spacers attached to rack uprights and not on upright
   e. Be accessible from front and rear of rack
   f. Be designed to space slots/fingers at 1 RU intervals to align with rack-mounted equipment

F. Equipment Rack Ground Busbar

1. Material: Copper
2. Mounts horizontally in rack
3. Mounting configuration EIA universal mounting hole pattern , tapped #12-24.

G. Miscellaneous

1. Releasable Cable Support Ties shall be:
   a. Hook & Loop type
   b. Individual units with latch
      1). Roll of hook & loop material is not acceptable.

2.2 CABLE RUNWAY

A. Manufacturers: CPI, B-Line

B. Cable Runway shall:

1. Be constructed of 0.065” thick steel
2. Utilize tubular stringers to support rungs.
   a. Stringers shall be 1-1/2” high.
   b. Rungs shall be welded to stringers and shall be spaced 9” on center.

3. Be painted with black epoxy

C. Runway width(s) shall be as shown on drawings.

2.3 TERMINATION BLOCKS

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Blocks shall be 110-style high-density cross-connect blocks.

C. Each horizontal row of block shall be capable of terminating one 25 pair binder group of Backbone Copper Cable, or six 4 pair Copper Cables.

D. Mechanical termination on blocks shall:

1. Have ability to terminate 22-26 AWG plastic insulated, solid and stranded copper conductors.
2. Provide direct connection between horizontal or backbone cable and jumper wires.
3. Be designed to maintain cable pair twists as closely as possible to point of mechanical termination.

E. Blocks for Horizontal Cabling shall use 4-pair connecting blocks; blocks for backbone cabling shall use 5-pair connecting blocks.

1. Blocks shall identify pair position by color designation.
   a. Colors shall be Blue, Orange, Green and Brown for Horizontal Cables.
   b. Colors shall be Blue, Orange, Green, Brown and Slate for Backbone Cables.
   c. Markings shall designate Tip and Ring conductors.

F. Backbone Voice Blocks shall:

1. Be rack-mounted.
2. Meet or exceed TIA Category 3 performance criteria

3. Terminate up to 100 pairs (each block)

G. Horizontal Cable Managers (Jumper Troughs) designed for use with blocks shall be:

1. Manufactured with high-strength, flame-retardant thermoplastic
2. Designed for easy cable insertion or withdrawal
3. 2 RUs high
4. Rack- or wall-mountable (with legs) to match block configuration

H. Horizontal Cable Managers designed for use at top of column of blocks shall be 188B type. 188B type cable manager shall:

1. Be constructed of metal with two plastic distribution rings
2. Have legs to allow space for routing cables behind Backboard
3. Have dimensions 6.5” high x 10.7” wide

I. Vertical Cable Managers for wall-mounted Termination Blocks shall utilize distributing rings.

1. Rings shall be metal and be split to facilitate passage of jumper wires.
2. Minimum Dimension of each ring shall be 5” square (minimum).

2.4 MODULAR PATCH PANELS

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Panels shall:

1. Consist of Modular-to-IDC connector system
2. Be rack-mountable in standard EIA 19” equipment racks
3. Be 2 RUs high
4. Accommodate 48-port modular jacks in two rows of 24-ports
5. Be designed to terminate 4-pair, 100-Ohm UTP cables
6. Have ability to terminate 22-26 AWG plastic insulated, solid and stranded copper conductors.
7. Be designed to maintain cable's pair twists as closely as possible to point of mechanical termination.
8. Have cable support and strain relief devices to secure cables at IDC connector.
   a. Panel and cable support hardware shall ensure that cabling minimum bend radius requirements are satisfied.
9. Have port identification numbers on both front and rear of panel.
10. Have color-coded pair designations on rear of panel.

C. Modular Jacks in Panel shall:

1. Be non-keyed, 8 position, 8-conductor (8P8C)

D. Panels shall meet or exceed TIA Category 6 performance criteria.

2.5 FIBER OPTIC PATCH PANELS

A. Manufacturers: Corning, Siemon, Panduit or Ortronics.

B. Patch Panels shall:

1. Be enclosed assemblies
2. Incorporate hinged or retractable front cover
3. Be rack mountable on standard TIA 19” equipment racks
4. Provide for strain relief of incoming cables
5. Incorporate radius control mechanisms to limit bending of fiber to manufacturer's recommended minimums of 1.2”, whichever is larger
6. Provide protection to both "facilities" and "user" sides of couplings.
7. Be configured to require only front access when patching
8. Incorporate patch cable routing space internal to patch panel enclosure.
   a. Routing space shall be front-accessible.

9. Include provisions for permanent labeling of fiber optic cables.
   a. Labeling shall be accessible from front of patch panel and shall not require disassembly of patch panel enclosure or removal of front cover.

C. Couplings shall be mounted on assembly that snaps into patch panel enclosure.

1. This assembly shall be designed to accept variety of coupler types including, ST, SC, duplex SC and high-density mini-connectors.
2. Coupling type shall be duplex LC
3. Coupling Color shall be as follows:
   a. Multimode: LASER-optimized 50/125 Multimode couplings shall be AQUA
   b. Single-mode: BLUE

D. Access to inside of panel enclosure during installation shall be from front and rear.

1. Panels that require disassembly of cabinet to gain entry will not be accepted.

E. Incoming cables shall not be accessible from patching area of panel.

1. Enclosure shall provide physical barrier to access of such cables.
2. Where factory-terminated cable assemblies ("pigtails") are spliced to cable, enclosure shall incorporate hardware for securing of splice tray and required cable, buffer tube and pigtail slack.

2.6 ENTRANCE PROTECTION

A. Manufacturers: Corning, Porta Systems, CommScope, Circa

B. Interface on Protection devices shall be as follows:

1. Input: 110-type block
2. Output: 110-type block

C. **U**nit shall be equipped with an internal fuse link.

D. Entrance protection shall:

1. Be listed primary protector
2. Accommodate industry standard 5 pin protection modules
3. Be provided with grounding lug

E. Covers on protector housing are required as follows:

1. On input side

F. Protection modules shall:

1. Be 3-element Gas Tube type
2. Have nominal DC Breakdown voltage of 230 V
3. Be self-resetting
4. Provide effective protection against "sneak current" events
5. Have fail-safe design to protect personnel and equipment from exposure to sustained high voltages and currents

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to project Drawings for communications equipment room layout and equipment placement.

B. New communications equipment rooms must be free from dust, dirt, and other foreign materials before installation of any termination hardware or termination of copper or fiber optic cables.
1. Door to room must be closed during termination if area outside room is not dust-free.

C. Follow manufacturer’s recommended installation and termination practices.

D. Provide necessary assistance to allow Owner or Carrier personnel to establish service on new cable system.

1. Includes general wiring overview, cable pair identification, and cross connect documentation (if applicable).

3.2 EQUIPMENT RACKS AND CABLE MANAGEMENT

A. Provide equipment racks as shown on project Drawings.

B. Assemble racks per manufacturer’s recommendations. Remove paint at the point(s) of contact of assembly hardware or use internal-external tooth lock washers to pierce paint to maintain ground continuity.

C. Bolt racks to floor.

D. Secure racks to cable runway as described below.

E. Provide Horizontal and Vertical Cable Management in equipment racks as follows.

1. Provide horizontal cable management above and below each rack mounted patch panel.
2. Provide vertical cable management between adjacent equipment racks and at rack row ends.

F. Provide each rack with:

1. Ground bar and #6 AWG Ground lug,
2. Minimum of fifty (50) 12/24 mounting screws,
3. Minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties.

G. Bond each rack mounted ground bar to telecommunications ground bus bar (TGB).

1. Use #6 AWG or larger copper conductor (green jacket).

3.3 CABLE RUNWAY

A. Provide cable runway and accessories necessary for complete system.

B. Size and layout of cable runway shall be as shown on project Drawings.

C. Install above equipment racks at 7’-6”.

D. Align with equipment racks as shown on drawings.

E. Brace to racks with support brackets made by runway or rack manufacturer intended for this purpose.

F. Use radius drops where cables drop from tray to rack and at elevation changes of 6” or more.

G. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 1/2”, with tray loaded to capacity.

H. Where cable runway is supported from building structure:

1. Provide 3/8” threaded rods for support of 12” wide or smaller runway.
2. Provide 1/2” threaded rods for support of runway greater than 12” in width.

I. Bond runway components together using manufacturer's standard accessories.

J. Fasten cables to runway at intervals not to exceed 4 ft.

3.4 TERMINATION BLOCKS

A. Provide blocks per project documents.

B. Terminate Backbone Voice Cables on termination blocks.

1. Strip lengths & termination of all cabling to be per manufacturers recommendations.

C. Provide 110 blocks as follows:

1. Backbone Voice Cabling at horizontal cross-connect on free-standing equipment racks.
2. Backbone Voice Cabling at main cross-connect on free-standing equipment racks.

D. Install Blocks:

1. No higher than 72” AFF to top-most block
2. Top to bottom, left to right beginning no closer than 12” from left wall

E. Provide horizontal troughs between each termination block.

F. Provide horizontal troughs at top of each block column.

G. Provide vertical managers to right and left of each block column.

H. Cabling entering and exiting fields shall be neatly laced, dressed and supported.

I. Contractor shall be responsible for jumper wiring between horizontal and backbone cabling.

3.5 MODULAR PATCH PANELS

A. Provide panels per project documents.

B. Mount patch panels in 19” equipment racks.

C. Position cables in sequence of:

1. Telecommunications Outlet ID for horizontal cabling
2. Pair number for backbone cabling

D. Terminate cables using 568B wiring standard.

E. Provide horizontal management above and below each patch panel.

F. Provide minimum of 4 screws to secure each patch panel onto rack.

G. Bond F/UTP cable shield and drain wire to connecting hardware per manufacturer’s instructions. Bond connecting hardware to the Telecommunications grounding system.

3.6 FIBER OPTIC PATCH PANELS

A. Provide Fiber Optic Patch Panels and coupling assemblies at horizontal and main cross-connect locations.

1. Provide minimum of 4 screws to secure each patch panel onto rack.

B. Provide couplings in coupling assemblies and mount coupling assemblies and blank covers in patch panels.

C. Position fibers consecutively - starting with lowest number - and mapped "position for position" between patch panels.

1. There shall be no transpositions in cabling.

D. Keyways on duplex couplings shall be oriented to establish "cross-over" in cabling system.

1. Convention defined by TIA-568-C.0 (Annex B, Section B.3.2) shall be used.
2. Reverse-pair positioning shall not be used.

E. Provide blank covers for unused coupling assembly spaces in panels.

F. Follow manufacturer's guidelines for connector type(s) provided.

1. Clean connectors with specialized dry-cleaning product from Fluke or Cletop.

G. Provide dust caps for couplings.

H. Where factory-terminated cable assemblies ("pigtails") are spliced to cable, prepare and splice cables and fibers per manufacturers' guidelines.

3.7 ENTRANCE PROTECTION

A. Provide protector at each end on inter-building backbone copper pairs.

1. Position protector as close as possible to building entrance.

B. Install per manufacturers recommendations.

C. Ground protector assemblies to Telecommunications Grounding Busbar via #6 AWG (minimum) conductors.

D. Provide Protector Modules for 100% of pairs terminated.

E. If special tool is required to open protector housing, provide 2 such tools to Owner at completion of work.

3.8 FIELD TESTING

A. General

1. Refer to Section 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.
2. Refer to referenced technical sections for detailed requirements to testing of each cable sub-system.

3.9 DOCUMENTATION

A. General

1. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding documentation requirements.

END OF SECTION 271100

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SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for backbone cabling for Communications Systems.

1.2 DESCRIPTION

A. Backbone Cabling links telecommunications rooms or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings.

B. Backbone cable types include:

1. Twisted-Pair Copper
2. Fiber Optic

C. Refer to Project Drawings which detail Backbone Cable System topology and conductor/fiber counts.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 0528.36 - Cable Tray for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1000 - Structured Cabling
8. Section 27 1100 - Communications Equipment Room Fittings
9. Section 27 1500 - Communications Horizontal Cabling
10. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

B. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.4 REFERENCES & STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify pertinent References and Standards.

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

1. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
   a. Section shall have manufacturer's cable markings visible.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

2.2 TWISTED PAIR CABLING

A. General:

1. Manufacturers: CommScope, Superior Essex, Belden
2. Cable shall be standard exchange type telephone cable.
   a. This is defined as paired multi-conductor, thermoplastic insulated, copper cable characterized by an average mutual capacitance of 83 (+4/-5) nano-Farads per mile at 1000 Hz.

3. Cabling shall:
   a. Be constructed of individually twisted pairs.
   b. Be suitable for installation in environment defined.
   c. Be packaged to minimize tangling and kinking of cable during installation.

4. Identify conductors by insulation color.
5. Color code shall follow industry standard of 10 distinctive colors to identify 25 pairs.
   a. Marking of each mate of primary conductor in pair with color of that primary conductor is optional.

6. When cables of larger than 25 pairs are required, cable core shall be assembled into 25-pair sub-units.
7. Wrap super units with solid color thread that follows primary color scheme of white, red, black, yellow and violet.
8. Cable jacket shall be marked at 2 ft intervals indicating manufacturers' identification, pair count, AWG and sequential footage.

B. Backbone UTP Cable (Intra-building):

1. Cable shall meet following minimum requirements:
   a. Size: 24 AWG solid annealed copper pairs
   b. Number of Pairs: as shown on Project Documents
   c. Impedance: 100 Ohms ± 15%
   d. Jacket Color: Grey or White
   e. Shield: Overall, continuous corrugated aluminum bonded to outer jacket
   f. Cable Rating: NEC Article 800 Type CMR, UL listed

C. Backbone UTP Cable (Outdoor):

1. Cable shall meet following minimum requirements:
   a. Size: 24 AWG solid annealed copper pairs
   b. Number of Pairs: as shown on Project Documents
   c. Impedance: 100 Ohms ± 15%
   d. Jacket Color: Black
   e. Shield: Overall, continuous corrugated aluminum bonded to outer jacket

2. Cable shall be suitable for installation in underground duct.
3. Cable shall incorporate moisture-resistant filling and flooding compounds.

2.3 FIBER OPTIC CABLE

A. General

1. Manufacturers (Cable): Corning, Siemon, Berk-Tek, CommScope
2. Manufacturers (Optical Fiber): Corning, Alcatel
3. Fibers utilized in installed cable shall be traceable to manufacturer.

B. Optical Fiber - General

1. Optical fibers shall:
   a. Be sufficiently free of surface imperfections and occlusions to meet optical, mechanical, and environmental requirements of this specification.
   b. Have been subjected to minimum tensile proof test by fiber manufacturer equivalent to 100 kpsi.

2. Factory optical fiber splices are not allowed.
3. Coatings shall be mechanically strippable without damaging optical fiber.

C. Single-mode Optical Fibers:

1. Single-mode Optical Fibers:
2. Fiber Type: Single-mode
3. Strand Count: as shown on Drawings
4. Transmission Windows: 1310 nm, 1550 nm
5. Core Diameter: 8.3 micron
6. Cladding Diameter: 125 micron ± 1 micron
7. Coating Diameter: 245micron± 10 micron
8. Maximum Attenuation:
   a. 1310 nm: 0.5 dB/km (at 23° ± 5°C)
   b. 1550 nm: 0.4-dB/km (at 23° ± 5°C)
   c. When tested in accordance with FOTP 3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.05 dB/km at 1550 nm. Maximum attenuation change shall not exceed 0.15 dB/km at 1550 nm.
   d. Water Peak Attenuation: 1383 ± 3 nm (dB/km) ≤ 0.4

9. Point Discontinuity: < 0.1 dB at specified wavelengths

D. Indoor Backbone Fiber Optic Cable

1. Cable shall:
   a. Be suitable for installation in free air, in building risers, in conduit, in cable tray and in innerduct.
   b. Be dielectric materials (no conductive materials).

2. Cable shall meet the following specifications:
   a. Buffer Diameter: 900 micron (tight buffer)
   b. Jacket Color
      1). Multimode: ORANGE
         a). Exception: LASER-optimized 50/125 Multimode: AQUA
      2). Single-mode: YELLOW
      3). Hybrid (Multimode + Single-mode): BLACK
   c. Cable Rating: OFNR
   d. Strength Member: Aramid Yarn
   e. Storage Temperature: -40°F to 158°F (no irreversible change in attenuation)
   f. Operating Temperature: -34°F to 158°F (no irreversible change in attenuation)
   g. Humidity Range: 0 to 100%
   h. Maximum Tensile Strength:
      1). During Installation – 2700 N (no irreversible change in attenuation)
      2). Long Term – 1000 N
   i. Bending Radius:
      1). During Installation - 20 times cable diameter
      2). No Load - 10 times cable diameter

E. Indoor-Outdoor Backbone Fiber Optic Cable

1. Cables shall:
   a. Incorporate dry water-blocking materials
   b. Be all dielectric (no conductive materials).
   c. Be suitable for installation in underground conduit, in innerduct and indoor.

2. Cable shall meet the following specifications:
   a. Buffer Type: Loose Tube
   b. Jacket Color: Black or Gray
   c. Cable Rating: OFNR
   d. Strength Member: Aramid Yarn
   e. Anti-buckling element: fiberglass
   f. Operating and Storage Temperature: -40°F to 158°F (no irreversible change in attenuation)
   g. Humidity Range: 0 to 100%
   h. Maximum Tensile Loading:
      1). During Installation - 2700 N (no irreversible change in attenuation)
      2). Long Term - 600 N
   i. Bending Radius:
      1). During Installation - 20 times cable diameter
      2). No Load - 10 times cable diameter

2.4 FIBER OPTIC CONNECTORS

A. Manufacturers: Corning, Siemon, Panduit, Ortronics.

B. Connectors shall:

1. Be LC-type.
2. Accept fibers having clad diameter of 125 micron.
3. Accept fibers having buffered diameter of 900 micron.
4. Sustain minimum of 200 mating cycles.

C. Connector ferrule shall be ceramic or glass-in-ceramic.

D. Connectors shall meet the following performance criteria:

Test Procedure	Max. Attenuation Change
1. Cable Retention (FOTP-6)	0.2 dB
2. Durability (FOTP-21)	0.2 dB
3. Impact (FOTP-2)	0.2 dB
4. Thermal Shock (FOTP-3)	0.2 dB
5. Humidity (FOTP-5)	0.2 dB

E. Optical fiber shall be:

1. Secured within connector ferrule with adhesive, or
2. Mechanically secured and mated to a factory-installed fiber stub that is fully bonded into the ferrule. Mechanical “splice” inside connector shall include an index matching gel.

F. Attenuation per connector shall not exceed 0.5 dB.

G. Reflectance (maximum) when mated with patch-cord made up of connectors of comparable design shall be as follows:

1. Multimode: -20 dB
2. Single-mode: -40 dB

H. Color of LC Connector shall be as follows:

1. Multimode: LASER-optimized 50 micron fiber shall be AQUA.
2. Single-mode: BLUE

PART 3 - EXECUTION

3.1 CABLE INSTALLATION AND TERMINATION

A. General

1. Provide cables as shown on Project Documents.
2. Size cables as shown on Project Documents.

3. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.

B. Backbone UTP Voice Cable:

1. Terminate cables on backbone voice cable blocks.
   a. Maintain cables pair twists to within 1” of termination.
   b. Remove cable jacket only to extent required to make terminations.

C. Fiber Optic Cable

1. Route backbone fiber optic cable in innerduct.
2. Ground any metallic cable elements (if applicable) per Code.
3. Terminate fiber strands on Fiber Optic Connectors mated to couplings mounted in Fiber Optic Patch Panels.
   a. Terminate all fibers.

4. Follow manufacturer's guidelines for connector type(s) provided.
   a. Clean connectors with specialized dry-cleaning product from Fluke or Cletop.

5. Fibers with coatings <900 micron shall be furcated (fanned-out) to minimum of 900 micron before termination.
   a. Provide buffer tube fan-out kits for fibers terminated in patch panel couplings.

6. Provide cable slack in each backbone fiber optic cable.
   a. Slack shall be in addition to length of fiber required for termination requirements.
   b. Store cable slack in enclosure designed for this purpose.
   c. Slack required shall be as follows:
      1). Backbone Intra-Building: Minimum of 16 ft (each cable if applicable) coiled and secured at one end (preferably at Telecom Room).
      2). Backbone Inter-Building: Minimum of 50 ft (each cable if applicable) coiled and secured at one end (preferably at Equipment Room).
      3). Maintenance Holes/Manholes: Minimum of 1-1/2 times inside dimension of Maintenance Hole/Manhole.

3.2 FIELD TESTING

A. General

1. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performance of compliance testing.
   a. Contractor shall be responsible for testing each system end-to-end.

B. Backbone UTP Cable Testing

1. Verify voice cable pairs for wire map (transposed/reversed/split pairs) and shorts through toning of each conductor.
2. Verify cable shield or coupled bonding conductor for end-to-end continuity.

C. Backbone Fiber Optic Cable Testing

1. Pre-Installation Testing
   a. Pre-installation testing shall be done at contractor option.
   b. Submit cable manufacturer's test report for each reel of cable provided.
      1). Verify fiber attenuation, bandwidth and length values as specified on cable data sheets supplied with cable reels.
   c. Visually inspect reels and packaging for damage.

2. Post-Installation Testing
   a. Clean fiber optic connectors before beginning testing.
      1). Using fiber tester capable of fiber end face inspection is strongly encouraged to help minimize requirement for retesting due to dirty connectors.
   b. Testing shall include:
      1). Optical Attenuation
      2). Optical Time Domain Reflectometry (OTDR)
   c. Optical Attenuation
      1). Light Source: VCSEL for 850 nm tests; FP LASER for 1300 nm tests
      2). Measure Optical Attenuation on terminated fibers.
         a). Include optical connectors and couplings installed at fiber endpoints.
      3). Test multimode fibers using EIA/TIA 526-14A, Method B.
      4). Test single-mode fibers using EIA/TIA 526-7-1998. Method A.1.
      5). Test fibers in both transmission directions.
      6). Test multimode fibers at 850 ± 30 nm and 1300 ± 20 nm wavelengths.
      7). Test single-mode fibers at 1310 ± 10 nm and 1550 ± 10 nm wavelengths.
      8). Fiber lengths less than or equal to 300 ft shall test to ≤ 2.0 dB loss.
      9). Fiber lengths greater than 300 ft shall test to loss value less than link loss budget for installed connectors and fibers.
   d. Optical Time Domain Reflectometry (OTDR)
      1). Verify fiber integrity using an Optical Time Domain Reflectometer (OTDR).
         a). Includes terminated and (if applicable) un-terminated fibers.
      2). OTDR(s) shall incorporate high-resolution optics and short pulse-width options optimized for viewing of short cable sections.
         a). Pulse-width shall be 10-ns or less for cable lengths greater than 100 meters.
         b). Pulse-width shall be 5-ns or less for cable lengths less than 100 meters.
      3). OTDR traces shall be performed in one direction using access jumpers at transmit and receive ends.
         a). Minimum length of access jumper at launch end shall be minimum 330 ft long for multimode or 990 ft long for single-mode, unless recommended otherwise by test equipment manufacturer.
      4). Test multimode fibers at 850 ± 30 nm wavelength.
      5). Test single-mode fibers at 1310 ± 10 nm wavelengths.
      6). Examine traces for continuity and anomalies to confirm fiber link integrity.
         a). Point discontinuities in excess of 0.2 dB for multimode fibers or 0.1 dB for single-mode fibers shall be cause for rejection of cable.
         b). Any reflection in trace - except at patch panels - shall be cause for rejection of cable.

c). Submitted test results shall show only fiber under test and shall have trace boundaries set to show fiber under test and not launch cords or other extraneous data.

d). Set event markers to accurately reflect overall attenuation of installed fiber optic cable and connectors.

7). OTDR tested links showing excessive backscatter immediately following connector shall have connector cleaned and/or re-polished and then retested.

3.3 DOCUMENTATION

A. General

1. Refer to Section 27 0000 - General Communications Requirements for general guidelines regarding documentation requirements.

B. Backbone Copper Cable

1. Document pair count assignments by cable.
2. Document cross-connects between backbone, and horizontal or tie cabling.
   a. Documentation shall be in the form of a spreadsheet which relates backbone pair count with horizontal cable or tie cable information. Base horizontal cable information on outlet designation and pair count.

C. Backbone Fiber Optic Cable

1. Files containing Attenuation and OTDR traces of individual optical fiber "signatures" shall be so named as to identify each individual fiber by location in cable system and fiber number or color.
2. OTDR test results shall be consistent in format and presentation, including:
   a. Scale
      1). Scale or window of test result view shall show only enough trace to view fiber under test plus launch cords at both ends.
      2). View shall not show backscatter beyond end of fiber.
   b. Pulse width
   c. Units (English or Metric)
   d. Cursor placement
   e. Labeling

END OF SECTION 271300

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SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.2 DESCRIPTION

A. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at Telecom Room) and Telecommunications Outlet.

B. Horizontal Cable types include:

1. 4-pair Copper Unshielded Twisted Pair (UTP)
2. Coaxial

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 0528.36 - Cable Tray for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1000 - Structured Cabling
8. Section 27 1100 - Communications Equipment Room Fittings
9. Section 27 1300 - Communications Backbone Cabling
10. Section 27 1600 - Communication Connecting Cords, Devices and Adapters.

B. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identifies pertinent References and Standards.

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Definitions used in this and related Sections.

B. In this section, "Telecommunications Outlet" is considered to consist of Frame/Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blanks fitted to unused jack positions, and labeling/identification components.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related Sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

1. Samples of each Telecommunications Outlet Faceplate type to confirm color and material.
2. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
   a. Section shall have manufacturer's cable markings visible.

3. Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.

1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

D. 4-Pair Horizontal Copper Cables and Modular Jacks are application independent (e.g. no distinction between “voice” and “data”).

2.2 4-PAIR HORIZONTAL COPPER CABLE

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Cables shall be suitable for installation in environment defined

C. Cabling shall be packaged to minimize tangling and kinking of cable during installation.

D. Configuration:

1. Number of Pairs: 4 twisted pair
   a. Pair twists of any pair shall not be same as any other pair.
   b. Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA 568.

2. Conductors: insulated solid annealed copper pairs
   a. Category 3 - 5e: 24 AWG
   b. Category 6 & 6A: 23 AWG
   c. Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.
      1). By pair number, pair colors or dominant band are:
         a). Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
         b). Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
         c). Pair 3: Tip - White/Green; Ring - Green (or Green/White)
         d). Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

3. Shield: None
   a. Drain Wire: None

4. Cable Rating: NEC Article 800 Type CMP, UL listed
5. Maximum outside diameter:
   a. Category 5e: 0.22 inches
   b. Category 6: 0.25 inches
   c. Category 6A: 0.30 inches

E. Horizontal Data Cable:

1. Shall meet or exceed TIA Category 6 performance requirements.
2. Shall not incorporate an overall shield.
3. Jacket Color: Blue

F. Horizontal Voice Cable:

1. Shall meet or exceed TIA Category 6 performance requirements.
2. Shall incorporate an overall shield.
3. Jacket Color White

2.3 TELECOMMUNICATIONS OUTLET

A. Manufacturers: Refer to System Requirements list in 27 1000

B. Connectors (modular jacks, fiber optic couplings and coaxial connectors (as applicable)) shall snap onto faceplate.

1. In surface-mount designs (if applicable) Jacks and connectors may mount to frame onto which coverplate is mounted.

C. Work Area Faceplate

1. Wall-mounted faceplates intended to be used in general work areas shall:
   a. Be configured to mount on standard, single gang opening when wall mounted.
   b. Accommodate minimum of 4 modular jacks and connectors.
   c. Be constructed of high impact plastic (except where otherwise noted).
   d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.
      1). Triple row faceplates with no provisions for labeling of middle outlet row are not acceptable.
      2). Designation strips shall be fitted with clear plastic covers.
      3). Designation strips and covers shall be positioned over faceplate mounting screws.

2. Faceplate Color: White.

D. Wall-mount Telephone Faceplate

1. Faceplates intended to be used in locations where wall mounted telephone set is required shall:
   a. Be stainless steel construction.

b. Accommodate 1 modular jack meeting performance requirements for "Voice" jack as defined above.
   1). Modular jack shall be positioned to mate with wall-mounted telephone.
c. Mount on standard single gang opening.
d. Include mating lugs for mounting wall-mounted telephone.

E. Faceplate - Wireless Access Point Location

1. Faceplates supporting Wireless Access Point (AP) shall:
   a. Accept 2 modular jacks or connectors.
   b. Be Surface-mounted.
   c. Be made of High Impact thermoplastic.

2. Faceplate Color: White

F. Faceplate - Surface Raceway

1. Faceplates intended to be used on surface raceway shall:
   a. Accept 4 modular jacks or connectors.
   b. Snap into raceway opening and be retained by integral latching tabs.
      1). Match standard opening of raceway type(s) to be installed.
   c. Have an optional extender bracket available to increase mounting depth.
   d. Be made of High Impact thermoplastic.
   e. Incorporate recessed designation strips for identifying labels.
      1). Raceway faceplate color shall be match color of raceway.

G. Faceplate - Modular Furniture

1. Faceplates intended to be used on modular furniture shall:
   a. Accept 2 modular jacks or connectors.
   b. Snap into modular furniture opening and be retained by integral latching tabs.
   c. Match standard opening of furniture type(s) to be installed. Furniture types include:
   d. Have an optional extender bracket available to increase mounting depth as required to maintain cable bend radius within manufacturers' recommendations.
   e. Be made of High Impact thermoplastic.
   f. Incorporate recessed designation strips for identifying labels.
      1). Modular furniture faceplate color shall be match color of furniture panel.

2.4 MODULAR JACK

A. Manufacturers: Refer to "Telecommunications Outlet" above.

B. Modular Jacks shall be:

1. 8-position, 8-conductor (8P8C)
2. Non-keyed

C. Jacks shall have an attached color-coded wiring instruction label as an aid to installer.

D. Interface between jack and station cable shall be insulation displacement type contact.

E. Termination components shall maintain cable's pair twists as closely as possible to point of mechanical termination.

F. Jack contacts shall have minimum of 50 micro-inches of gold plating.

G. Jacks shall be supplied with installed dust covers to protect jack opening and internal elements during installation until jack is in use.

1. No damage to Jack pinning shall result from insertion or removal of covers.

H. Data Jack shall:

1. Meet or exceed performance requirements of TIA Category 6.
2. Be color Blue
   a. Alternately, color-coded Bezel or Icon may be used to identify Jack type.

I. Voice Jack shall

1. Meet or exceed performance requirements of TIA Category 6.
2. Be color White
   a. Alternately, Color-coded Bezel or Icon may be used to identify Jack type.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to project Drawings for outlet and Consolidation Point locations.

B. Provide Modular Jacks, Coaxial Connectors (if applicable) and Fiber Optic couplings (if applicable) in faceplates as shown on Project Documents.

1. Provide 1 faceplate per Telecommunications Outlet symbol shown on Project Documents.
2. Provide 1 modular furniture mounted faceplate per modular furniture symbol shown on Project Documents.

C. Maximum 4-pair Category-rated horizontal cable length shall not exceed 295 feet (90 m) measured from horizontal cross-connect (typically at TR) to Telecommunications Outlet.

1. Includes slack required for installation and termination.
2. Contractor is responsible for installing station cable to avoid unnecessarily long runs.
3. Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.

D. Follow manufacturers recommended termination practices.

3.2 CABLE INSTALLATION AND TERMINATION

A. General

1. Refer to Section 27 0000 - General Communications Requirements and Section 27 1000 - Structured Cabling for general cable installation requirements.
2. Provide "Service Loop" for every Horizontal Cable in ceiling above outlet.
   a. Loop length shall be 3.3 ft
   b. Total length of 4-pair Category-rated horizontal cable including loop shall not exceed 295 feet (90 m).
   c. Place loop in ceiling at last support (e.g. J-Hook) before cables enter fishable wall, conduit, surface raceway or box.
   d. Coil loop in figure 8 configuration.
   e. Loop radius (minimum) shall be 4X minimum bend radius for cable.

3. During installation, minimum bend radius shall be eight times outside diameter of UTP cables and 20 times outside diameter of fiber cables.

B. Horizontal Copper Twisted-Pair Cabling

1. Provide horizontal copper twisted pair cable between horizontal cross connect (typically at Telecommunications Room) and Telecommunications Outlet.
2. At Telecommunications Outlet, terminate each 4-pair Horizontal Cable on 8P8C Modular Jack.
   a. Terminating one cable on more than one jack is not allowed.

3. At horizontal cross-connect, terminate:
   a. Each 4-pair cable on 8P8C Modular Jack in Patch Panel.
   b. Each 4-pair cable designated as for "Data" on 8P8C Modular Jack in Patch Panel.
   c. Each 4-pair cable designated as for "Voice" on 8P8C Modular Jack in Patch Panel.

4. Terminate cables using 568B wiring standard.
5. Cable jacket shall be continuous to within 1/2” of termination.
6. Preserve pair twists to point of termination.
7. Refer to Section 27 1100 - Communications Equipment Room Fittings for termination instructions for Modular Patch Panel and Termination Block.

3.3 TELECOMMUNICATIONS OUTLET

A. Faceplates shall be configured to provide connectivity as required by location. Refer to schedules.

B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box, raceway or modular furniture.

1. Use faceplate extender if required to provide adequate clearance between jack and furniture or raceway panel to maintain minimum cable bend radius.
2. Provide blank(s) in unused jack/connector positions. Match color of blank to faceplate color.

C. Position Telecommunications Outlet for wall-mounted telephone in area clear of other utilities and wall mounted hardware.

1. Coordinate with other trades to maintain 8” clear space (minimum) on all sides from faceplate centerline.

3.4 FIELD TESTING

A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.

1. In addition, refer to sub-sections below for cable type under test.

B. 4-Pair Horizontal Copper Cable

1. Test from:
   a. Horizontal Cross-connect (HC) to Jack at Telecommunications Outlet (TO).
   b. Horizontal Cross-connect to Jack at Consolidation Point (CP)
   c. HC – CP – TO. Test is in addition to HC-CP test described above.

2. Testing shall be per TIA-568 Permanent Link test configurations.
3. Maximum length of station cable shall not exceed 300 ft.
4. Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).
   a. Identify and correct defective, split or mis-positioned pairs.

5. In addition to above, Performance Testing shall be performed on all cables. Testing of Transmission Performance shall include the following:
   a. Length
   b. Insertion Loss / Attenuation
   c. Pair-to-pair NEXT
   d. PSNEXT
   e. Pair-to-pair ELFEXT (Equal Level Far End Cross-talk)
   f. PSEFEXT
   g. Return Loss
   h. Propagation Delay
   i. Delay Skew

6. Test cables to maximum frequency defined by standards covering specified performance category.
7. Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.
   a. Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.

8. Include the following (testing of permanent Link w/ PoE) if project includes mid-span injectors as part of infrastructure. Otherwise delete.

C. Horizontal Coax Cable

1. All cables shall be tested using Wire Test Instrument to:
   a. Verify length
   b. Verify Resistance
   c. Verify impedance
   d. Locate breaks/faults/incorrect terminations and large impedance changes

2. Terminate cable - as required by individual tests - with its characteristic impedance.

3.5 DOCUMENTATION

A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for documentation guidelines.

B. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations, numbering and other detail necessary to document cable installation.

END OF SECTION 271500

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SECTION 275113 - OVERHEAD PAGING

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for multi-zone analog paging system.

1.2 DESCRIPTION

A. Provide a complete and fully operational multi-zone paging system for the pickup, amplification, distribution, and reproduction of voice and/or other audio program material. The system shall be of modular design to facilitate both expansion and service and shall be completely solid state. All necessary hookup and installation shall be by a factory approved representative.

B. Paging system shall interface with the existing VOIP phone system to allow pages to originate from any designated handset in the phone system.

C. Paging system shall interface with the fire alarm/emergency notification system to allow emergency annunciations.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems
5. Section 27 0528.36 - Cable Tray for Communications Systems
6. Section 27 0553 - Communications Systems Identification
7. Section 27 1000 - Structured Cabling
8. Section 27 1500 – Communications Horizontal Cabling
9. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

B. Related sections in other Divisions of Work:

1. See individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

1. FCC Part 15 EMI Emission Standard

2. FCC 47 CFR Part 68
3. UL 1480 General Signaling
4. UL 6500 Audio/Visual and Musical Instrument Apparatus for Household, Commercial and Similar General Use (IEC 60065)
5. UL 2403 Fire Tests for Heat and Visible Smoke Release for Discrete Products and their Accessories in Air Handling Plenum

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements which provide information on Definitions used in this and related Sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements which provide information on Abbreviations and Acronyms used in this and related Sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

B. Additional work by owner:

1. Participate in coordination of the interface between the paging system and additional systems identified above.
2. Provide all music and/or verbal content and is responsible for any and all licensing (e.g. ASCAP), royalties, etc. required for use of copyrighted material (if applicable).

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

1. Contractor Certification documents which document participation in Installers Program operated by System Manufacturer.
2. Product datasheets and literature as required to describe equipment proposed and all operating modes.
3. Outline drawings of equipment showing overall dimensions, power, control and signal wiring.
4. Termination drawings and one-line Paging System riser drawings showing all equipment and room numbers.

C. Upon request, submit Certified Installer name(s) assigned to Project.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications which identify general quality assurance requirements for the Project.

B. In addition the following items are applicable:

1. Quality of Materials and Equipment
   a. All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.
   b. At the time of submittal the Contractor shall supply the latest model for each piece of equipment.
   c. All equipment shall be UL listed, or equivalent.

2. Substitutions
   a. See general provisions of the contract.
   b. Bid shall include all equipment and work as outlined in these documents. Substitutions shall be submitted as alternate items with bid and at the time of bid submission.

C. Systems shall provide clear, natural sound uniformly distributed throughout the listening areas. The entire electro-acoustic system shall be carefully balanced and equalized to provide a high order of intelligibility and gain without feedback or reverberant coloration. Adequate power capability shall be provided to insure the necessary dynamic range and prevent distortion at peak levels.

D. Acoustic Frequency Response: 50 Hz to 15 kHz, 3dB/octave roll-off above 2000 Hz ±2dB. Measured at continuous one-third octave bands at seated ear height.

E. Intelligibility: Greater than 0.50 STI at any seat in the audience area.

F. Noise: System noise shall not exceed an equivalent input noise of -120dBu based on a 20 kHz noise bandwidth. Predominant noise component in the system output under any operating condition will be that of the input stages. Adjustment of any system controls shall produce no audible clicks, pops, thumps, or other spurious noises.

G. Acoustic Signal-to-Noise Ratio (including crosstalk and hum at all input/output levels): 60dB.

H. Dynamic Range: The system shall deliver a minimum sound pressure level of 60 dB with a 10 dB peaking factor to any location at seated ear height at less than 5% total acoustic harmonic distortion. When system is driven to maximum output, clipping shall first occur in the power amplifiers.

I. Total Harmonic Distortion: 0.05% maximum from 20Hz to 20kHz.

J. Polarity: A positive pressure at any system microphone shall produce a positive pressure from the speakers.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 - PRODUCTS

2.1 CONTROLLERS

A. Manufacturer: Basis of Design: Bogen, acceptable manufacturers: Atlas Sound, TOA

B. Provide active equipment, cabling, termination hardware, associated components, power supplies, programming, licensing and labor for a complete and working system, which will:

1. Provide live and prerecorded paging to loudspeakers in areas identified on within the contract documents
2. Transmit live announcements, from paging stations and designated handsets through telephone system interface to selected loudspeakers with priority override for paging instructions.
3. Transmit prerecorded announcements, from paging stations and automatically from fire alarm/emergency system.
4. Allow for source selection by push buttons, which music program channel or microphone input selected.
5. Provide paging zone selection either locally or globally using telephone dialing pad.
6. Allow for aural and visual monitoring of each source channel before and during distribution.

C. Provide speaker assemblies and associated equipment as indicated on drawings.

D. System shall be configured to serve 4 paging zones.

1. System shall have capacity to be expanded to serve 200 paging zones.
2. Paging Zones shall be one-way plus “All-Call”.
3. Each paging zone group shall be field-programmable.

E. Power:

1. Provide 24 V power supply for required devices.

F. System shall be modular, allowing for serving of additional zones.

G. System shall include:

1. Emergency call feature which shall override normal paging features of module, sound a user-selected alert tone in all zones, and open an audio channel for emergency page.
   a. Feature shall be activated by a customer-supplied contact closure (requires a pre-amplified microphone with built-in contact closure or microphone and other customer-supplied switch).
   b. Alternately, it shall be possible to field-program an emergency-call zone group which shall preempt normal operation, sound alert tone, and open audio channel for an emergency page in any user-selected zone via a system interface or designated emergency paging station.

H. Active components shall be wall-mountable.

2.2 AMPLIFIERS

A. General

B. The loudspeaker load on any amplifier channel shall not exceed 90% of the amplifier's rated power output nor be less than 60% of the amplifier's rated power output.

C. Multi-Channel paging amplifier

1. Balanced or unbalanced outputs shall be provided for 16 Ohm, 25 V, 25 VCT, and 70 V loudspeaker distribution lines.
2. Power Output: 125 Watt continuous RMS.
   a. Deliver rated power at less than 1% distortion.

3. Frequency response of ±1 dB from 70 Hz to 15 kHz
4. Signal to Noise Ratio: greater than -90 dB at rated output (20 Hz to 20 kHz bandwidth).
5. Amplifier shall permit paging from telephone**.**
   a. Signal-activated paging channel shall automatically mute background music during a telephone page, eliminating need for manual activation of switches and use of external relays.
      1). Provision shall be included to set to mute level of background music during a page.
      2). Music level shall be returned to its normal level after a page.
   b. Telephone paging channel shall have a VOX sensitivity adjustment to eliminate transmission of background noise, and automatic output leveling (ALC) to compensate for varying voice levels and paging techniques of persons using system.

6. A night ringer shall be included to alert personnel of incoming calls during non-business hours. Night ringer shall be activated by a contact closure or by 90 Volt ring signal from telephone line.
7. Input terminals shall be furnished for a telephone line and LO-Z balanced microphone.
   a. A choice of RCA jack or screw terminals shall be provided for music source.

8. Terminals shall be provided to control music muting during a voice page, and for contact closure or ring signal activation of night ringer.
9. Bridging jacks shall be provided to bridge two amplifiers.
10. Provision shall be included to feed a 600 Ohm telephone line, LO-Z input or balanced microphone input of another amplifier. Use of an accessory line-matching transformer is acceptable for this purpose.
11. Individual controls shall be provided to set telephone and mic page volume, music volume, night ringer volume, VOX sensitivity, and music mute level.
12. Bass and treble controls shall permit tonal adjustments.
13. An automatic level control (ALC) and VOX sensitivity controls shall be included.
14. Indicators shall include:
    a. A peak level indicator which illuminates when amplifier is driven into clipping.
    b. A power indicator.

15. Amplifier shall operate from a 120 VAC, 60 Hz source, and shall be equipped with a resettable circuit breaker and thermal and electronic overload protection.

2.3 CEILING SPEAKERS

A. Manufacturer: Basis of Design: Bogen, acceptable manufacturers, JBL, TOA, Atlas Sound, Quam, Tannoy

B. Shall be 8” cone-type loudspeaker.

C. Loudspeaker shall include an integral transformer, capable of matching an 8-Ohm loudspeaker to a 25 Volt or 70 Volt line, and providing power taps of 4, 2, 1, 1/2, 1/4, and 1/8 Watt.

1. Transformer primary and secondary leads shall be stripped, tinned, and shall be at least 6" in length.

D. Performance:

1. Frequency response (minimum):+/-6dB from 70 Hz to 15 kHz.
2. Axial sensitivity: 95 dB 1W/4 feet

E. Grille:

1. Size: 13”
2. Construction: Steel.
3. Finish: White semi-gloss enamel

F. Ceiling Speaker Enclosure:

1. Protective enclosure for loudspeaker shall be designed for recessed installations.
2. Construction:
   a. One-piece heavy-gauge steel.
   b. Includes speaker mounting ring.
   c. Permanently attached foam anti-resonance insert.
   d. Rust-retardant black primer coating finish.

3. Four (4) combination 1/2" – 3/4" conduit knockouts shall be provided at 90 degree intervals.

G. Tile Bridge:

1. Load bearing T-bar support shall be capable of sustaining weight of specified speaker, grille and protective enclosure (if applicable) in suspended ceiling construction.
2. Construction:
   a. Steel
   b. Rust-retardant galvanized finish.

3. Unit shall measure: 24"W x 3/4"H x 14-3/4"D.

2.4 SURFACE CEILING SPEAKERS (PENDANT TYPE)

A. Description: Surface suspended ceiling mounted speakers for paging in unfinished (open) ceilings.

B. Specifications:

1. 1" tweeter and 4" woofer
2. Multiple taps to at least 16 watts.
3. Frequency Response: +/-6dB, from 75 Hz to 15kHz.
4. Sensitivity: 88 Db/1W/4 ft.
5. Finish: White

2.5 HORN SPEAKERS

A. Description: Wall mounted speakers for paging in high ambient noise areas.

B. Provide 4" square deep back-box with 1-gang mud ring at 10'-0" AFF.

C. Specifications:

1. Taps: 7.5, 15 and 30 watts
2. Frequency Response: =/-6dB from 225 Hz to 14 kHz.
3. Sensitivity: 98 dB, 1W/ft.
4. Tilt and swivel base
5. Weatherproof and paintable metal housing

2.6 MISCELLANEOUS

A. Telephone System Interface

1. Shall be capable of providing either trunk port or station port access to paging amplifier/amplified speakers, multi-zone paging adapter, or talk back amplifier/amplified speakers.
2. Module shall be designed for direct connection to:
   a. loop start and ground start trunks,
   b. PBX or KEY paging ports that supply a normally-open contact closure and DTMF capability
   c. Analog station ports
      1). Use of an access module is acceptable for this connection.

3. Paging frequency response shall be 200 Hz to 8000 Hz, ±1 dB or better.
4. Input/output impedance shall be 600 Ohms, nominal.
5. Powering shall be as follows:
   a. When used in station port access mode, device shall be line-powered and shall not require an external power supply.
   b. When used in trunk port access mode, it shall operate from 24 VDC @ 90 mA, or 48 VDC @ 105 mA.

6. Unit shall be capable of generating an 800 Hz (±20%), ½-second duration signal to be used as a pre-announce or confirmation tone.
   a. Tone level shall be controlled by a single screwdriver adjustment that shall be accessible without removing cover.

7. When used in station access mode, device shall be capable of three methods of release following a page:

a. Loop Current Interruption,
b. Voice-Operated Disconnect, and
c. Default Disconnect Timer.

8. Loop current interruption detection circuit shall, if particular line to which device is connected issues a disconnect signal (a loss of loop current for longer than 30 milliseconds), recognize this signal and immediately disconnect device from line.
   a. Voice-operated disconnect circuit shall be enabled/disabled via mode switches or an external signal.

9. A default disconnect timer circuit shall set maximum time allotment for paging and ensure that unit will always disengage line if other disconnect circuits are inoperative.
   a. Default disconnect timer duration shall be adjustable from 6 to 35 seconds.
   b. VOX disconnect timer duration shall be adjustable from 2 to 6 seconds.
   c. Controls shall be accessible without removal of cover and they shall be screwdriver-adjustable.

10. When used in trunk port access mode, device shall automatically terminate paging access upon release of trunk port.
11. An RCA-type jack shall be included to accept a line level input from a suitable background music source.
    a. A screwdriver-adjustable control shall be provided to set background music volume.

12. One set of normally open contacts shall be provided for use with ground start trunk port operation or for auxiliary equipment control.
    a. Contacts shall be rated at 30 VDC, 2 A.

B. End Of Line Device

1. Provides monitoring of speaker line integrity between the amplifier and end of line device.
2. Supports constant voltage (70V/100V) or low impedance systems
3. Dimensions: 1” x 6” x 3”

C. Ambient Noise Compensation Device

1. Provides monitoring ambient noise and automatically adjusts.
2. Supports constant voltage (70V/100V) or low impedance systems

D. Volume Control

1. Field Volume Control shall provide ability to locally adjust volume of speaker(s) serving area(s) as identified on drawings.
2. 10 levels of sound adjustment in 3dB increments.
3. Unit shall mount flush in a single-gang box.

2.7 EQUIPMENT RACKS

A. Manufacturer: Basis of Design: Middle Atlantic, acceptable manufacturers: CPI, Hubbell

B. Amplifiers racks shall be integral wall mount cabinets with standard 19" EIA mounting rails and 26-3/8" of vertical mounting space (minimum) and a minimum depth of 18 inches.

C. Unit shall consist of backbox and equipment cabinet joined by removable pin hinges. Cabinet shall have hinged door with keyed security lock.

D. Cabinets shall be keyed alike.

E. Enclosure shall include ventilation louvers and knockouts. Knockouts shall be located in backbox.

2.8 LOUDSPEAKER CABLE

A. Manufacturers: Belden, West Penn, Windy City

B. Loudspeaker cable shall be sized to limit cable losses to less than 0.5dB of the rated output of any amplifier channel.

C. Speaker cable shall be one pair, 18 AWG; unshielded.

D. Cable shall be listed CM

PART 3 - EXECUTION

3.1 GENERAL

A. Install system in accordance with manufacturer's recommendations.

B. Final connections and equalizing of systems shall be made by factory trained personnel.

C. Coordinate all pathways with other trades. Provide any special back boxes required to Division 26.

D. Mount Controllers, Amplifiers, Mixers, Supervisory Detection Systems on floor mounted racks or on walls within telecommunications rooms or where shown on project drawings.

A. Install amplifier(s) on wall per project drawings. Coordinate exact location with Owner.

B. Provide all rack kits and hardware required.

C. Do not install equipment until sufficiently protected from dust and overspray.

D. Select components, locate components, and provide grounding to prevent electromagnetic and electrostatic hum and oscillation.

E. Field wiring within racks must be accessible without removing electronic components.

F. System shall be installed as a 70 Volt system.

G. Loudspeakers:

1. Do not support speaker enclosures with lay-in tiles or GWB. Provide adequate support (using attachments to structural elements and/or metal mounting bars) for back-boxes so that no perceptible sag will occur once speaker and grille are mounted. Assume the following weights at a minimum:
   a. Eight-inch loudspeakers: 20 pounds.

2. Caulk enclosures to ceiling surface (e.g. lay-in tile or GWB) to form an airtight seal.
3. Loosely fill metal speaker enclosures with un-faced, 0.75 lb/cu. ft., glass fiber batting.
4. Verify polarity of each speaker voice coil prior to installation and connect to maintain uniform polarity.
5. Tap 70 volt transformers as shown, or to provide an amplifier load between 60% and 90% of rated capacity with all speaker-line attenuators (if any) set for minimum attenuation.
6. Install speaker and baffles to provide tight seal with ceiling and enclosure. Do not caulk baffle to ceiling.
7. Install so speaker grille is centered in tile or building element, with sides of grille or line between mounting fasteners parallel to ceiling grid or building lines.

H. At each horn or surface mount location:

1. Provide back box to connect incoming and outgoing conduits.
2. Route cable from back box to horn. Provide strain relief in knock out for cable as it exits back box.
3. Leave 6” cable service loop within each back box.

I. Run cabling in raceways provided.

1. Where installed in free-air, support cables using J-hook type cable supports installed in accordance with manufacturer’s installation requirements.
   a. Space J-hook cable supports every 10 ft or in accordance with cable manufacturer’s specifications, whichever distance is shorter.

2. Keep cables clear of other trades work.
3. Install cables splice-free unless otherwise specified.
4. Avoid abrasion and other damage to cables during installation.
   a. Visually inspect cables for cuts, blisters and abrasions during installation.

5. Replace contractor-damaged ceiling tiles to match color, size, style and texture.

J. Terminate cabling at loudspeaker locations and at amplifier location(s).

1. Music, Page, & Control interconnection wiring shall be per manufacturer’s recommendations.
2. Wiring terminated at terminal blocks shall have crimped type or soldered connections.

K. Maintain continuity on cable shield and drain wire throughout each zone.

1. Cable shield and drain wire shall bypass each speaker.
2. Bond shield and drain wire to communications ground at system hub/head-end.

L. At each speaker location:

1. Leave 10’ slack loop of speaker cable, from each direction. Neatly coil cable and secure with Velcro strap and place cable slack next to speaker.

M. Connect owner provided telephone input, precedence and music inputs.

N. Adjust all volumes and parameters on a per zone basis per Owner instructions.

O. Label system components and cabling.

1. Label amplifier and other switch settings determined during installation.
2. Label loudspeaker cables at each loudspeaker location cables with “IN” (from amplifier) or “OUT” (to next speaker) and Zone Identifier (e.g. number, letter, etc.).
3. Label loudspeaker cables at amplifier location cables with Zone Identifier (e.g. number, letter, etc.).
4. Labeling shall be by mechanical means.
   a. Hand lettered designations are not allowed.

5. Tags shall be non-removable.
6. Characters shall be Black Ink and printed on background of contrasting color.
7. Labels shall be as large as practicable while fitting properly.
   a. No lettering shall be smaller than 10-point.

8. Label cables with tag which is wrapped around cable sheath.

P. Test and adjust system to Owner’s satisfaction.

3.2 FIELD TESTING

A. Refer to Sections 27 0000 - General Communications Requirements and 27 1000 – Structured Cabling for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.

   1. In addition, refer to sub-sections below for cable type under test.

B. Tune and test system in accordance with manufacturer's recommendations and test plan.

C. Coordinate mute input testing with electrical contractor.

D. Verify that the system is completely free from hum, noise, parasitic oscillation, and RFI.

E. Verify that positive pressure at any microphone produces positive pressure from each loudspeaker. Verify that signal polarity is correct and consistent for all circuits and paths. Reverse polarity if required, and record which circuit was reversed.

F. With signal processors in “by-pass” mode, adjust gain controls so all components except power amplifiers reach rated nominal output simultaneously. For components which have rated maximum outputs between 18 and 25dBm and line level inputs, adjust each component for unity gain.

G. Adjust power amplifier input attenuators so power amplifiers reach clipping at 10dB above 0VU on the mixing console output meter.

H. Re-adjust gains if required for proper operation of each system and component. Measure and record any such re-adjustments; also record the reason adjustment was deemed necessary.

I. Measure and record the electronic signal-to-noise ratio of each complete signal path with all microphone inputs at full gain, or at gain settings which correspond to the onset of ringing for a single microphone, whichever is lower gain, and other controls at normal settings. During test, terminate microphone receptacles with 200 ohm resistors.

J. Adjust equalizers to optimize the specified frequency responses. Measure and record the electronic frequency response and the acoustic frequency response of the system before and after adjustments.

K. Measure and record the impedance of each speaker load at the main junction box or rack cabinet and total load on each amplifier. At a minimum, make measurements at 100, 1000, and 10,000 Hertz.

L. Make corrections as required so that the load impedance of each loudspeaker circuit is equal to or greater than rated load impedance of the amplifier.

M. Slowly sweep all low frequency and full range speaker systems with sine waves at 25% of rated maximum amplifier power output, or at 50% of rated continuous power capacity of loudspeakers, whichever is less, from 20 Hz to 20 kHz. Observe for audible or perceptible vibration or rattling of speaker components, mounting apparatus, or building elements. Under this Section, correct vibration or rattling of speakers or mounting apparatus to the satisfaction of the Engineer. Report vibration or rattling of other building elements to the Engineer; include frequency, characterization of observed rattling or vibration, and recommendations for correcting the rattling or vibration in the report.

N. Measure and record the maximum sound pressure level of pink noise at onset of amplifier clipping. Make measurement using both A-weighted and un-weighted (flat) settings of the Sound Level Meter (SLM).

O. Record the measured sound spectrum at representative test locations 5' above floor level away from demising partitions and walls or large reflecting surfaces. 75% or more of the measured spectrums shall be within +/- 2 dB of the area average. The maximum deviation at any point shall not exceed 3 dB from the overall (full band) average.

1. Record all test results and submit results to the Owner and Engineer for review. Show all test locations on plan drawings.

P. Notify Owner at least three (3) days in advance to participate in final acceptance test.

1. Test each input individually for proper operation.
2. Test each attenuator for proper operation.
3. Test and confirm proper zoning operation.
4. Test and adjust each speaker/horn for proper operation during unoccupied times and when mechanical systems are in operation.
5. Adjust all volumes at individual components for proper sound levels to Owners satisfaction.

3.3 DOCUMENTATION

A. Refer to Section 27 0000 –General Communications Requirements for documentation requirements.

3.4 OWNER TRAINING

A. Refer to Section 27 0000 –General Communications Requirements for owner training requirements.

B. Provide training for Owner's personnel on operation and maintenance of total system and each component.

1. Training shall be complete to enable owner personnel to operate system and to perform maintenance and troubleshooting functions.
2. Conduct training during normal business hours after system start-up and Owner acceptance.

3. Training shall include hands-on exposure to installed system.
4. Duration of training shall be 2 hours minimum.
5. Up to six (6) members of owner staff or representatives may attend.

END OF SECTION 275113

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SECTION 275129 - TWO-WAY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Two-way Communication System.

1.2 DESCRIPTION

A. Refer to Section 27 0000 - General Communications Requirements.

B. Complete, turnkey Two-way Communication system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

C. Two-way Communication system shall include following major components:

1. Two-way Communication Call Stations
2. Two-way Communication Master Stations
3. Two-way Communication Power Supplies

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Refer to Section 27 0000 - General Communications Requirements.

1.5 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements.

B. Design, cable and component selection, and installation practices shall conform with following:

1. IBC International Building Code
2. NFPA 70 - National Electrical Code
3. NFPA 72 - National Fire Alarm and Signaling Code
4. NFPA 101 - Life Safety Code

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements.

1.9 AUTHORITY HAVING JURISDICTION REVIEW MEETING

A. Prior to shop drawing submittal preparation, Contractor shall arrange and conduct meeting with Authority Having Jurisdiction (AHJ) to review and coordinate design and installation of Two-Way Communication system.

1. At minimum, attendees shall include:
   a. AHJ
   b. Owner's project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative
   c. Construction Manager project manager and site superintendent/field foreman
   d. Division 26 site superintendent/field foreman
   e. Division 27 project manager and site superintendent/field foreman
   f. Two-Way Communication system subcontractor/supplier project manager

2. At minimum, meeting agenda topics shall include:
   a. Review of proposed system equipment and devices
   b. Identification and discussion of proposed system's functional capabilities and limitations
   c. Identification and review of device locations
   d. Step-by-step review of system deployment execution plan
   e. Review of installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.

3. Meeting shall be scheduled with two weeks' minimum notice.
   a. Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.

4. Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.1 GENERAL

A. System shall provide two-way voice communication between call stations and master station.

B. If master station is not answered, system shall provide two-way voice communication with external constantly attended station and shall automatically communicate location of station initiating call using pre-recorded message unique to each call station.

2.2 TWO-WAY COMMUNICATIONS CALL STATIONS

A. Basis of Design:

1. Rath 2100-958-NSR

B. Acceptable Alternates:

1. Cornell

C. Features:

1. Flush wall-mounted
2. Stainless steel faceplate
3. Red mushroom-style pushbutton
4. Red “call received” indicator lamp
5. Microphone
6. Speaker

D. Specifications:

1. Operating Environment: 50° - 120° F

2.3 TWO-WAY COMMUNICATIONS MASTER STATIONS

A. Basis of Design:

1. Rath 2500-205FM

B. Acceptable Alternates:

1. Cornell

C. Features:

1. Flush wall-mounted
2. Powder-coated steel enclosure with hinged door
3. Visual and audible indication of incoming call
4. Handset

5. Handsfree speakerphone
6. Modem for automatic dial-out

D. Specifications:

1. Operating Environment: 50° - 120° F

2.4 TWO-WAY COMMUNICATIONS POWER SUPPLIES

A. Basis of Design:

1. Rath 2500-PWR24U

B. Acceptable Alternates:

1. Cornell

C. Features:

1. Integral battery backup

D. Specifications:

1. Input: 120 VAC
2. Output 24 VDC

2.5 TWO-WAY COMMUNICATIONS CABLE

A. General

1. Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, more stringent requirement shall govern.
2. Cable shall be plenum or riser rated as dictated by environment in which cable is installed.
3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.
4. Two-way Communications system cabling shall have minimum pathway survivability of Level 2 or 3, provided via either of following:
   a. Cable with CI rating for free-air installation
   b. Cable with CIC rating for installation in conduit

2.6 TWO-WAY COMMUNICATION J-TYPE CABLE SUPPORT HOOKS

A. Refer to 27 0528.29 for information and requirements

2.7 TWO-WAY COMMUNICATION RACEWAY AND BOXES

A. Refer to 27 0528.33 for additional information and requirements.

B. Conduit:

1. Minimum 3/4" trade size.
2. No flexible conduit of any type.

C. Boxes:

1. Minimum 4” square 2-1/8” deep.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Wiring color coding for each device type shall be consistent throughout installation.

B. System Supervision

1. System wiring shall be supervised.
2. Failure of either primary or secondary power supply shall result in trouble signal in accordance with section 10.14 of NFPA 72.

C. Two-way Communications Call Stations

1. Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.
2. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
3. Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

D. Two-way Communications Master Stations

1. Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.
2. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
3. Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

E. Cable

1. Systems Identification:
   a. Label system device cabling with unique alphanumeric identifiers that include:
      1). Architectural room number
      2). Associated system device type

3). Unique alphanumeric identifier

b. Refer to Section 27 0553 for additional information and requirements.

F. Configuration and Programming

1. Coordinate programming with Owner.

3.2 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 1-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 245129

SECTION 275319 - EMERGENCY RESPONDER RADIO REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Emergency Responder Radio Reinforcement system.

1.2 DESCRIPTION

A. Design and provision of a complete, turnkey Emergency Responder Radio Reinforcement system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

B. The Emergency Responder Radio Reinforcement system shall include the following major components:

1. Donor Antenna(s)
2. Surge Protection
3. Bi-Directional Amplifier / Repeater
4. Splitters
5. Directional Couplers/Taps
6. Coverage Antennas
7. Uninterruptible Power Supplies

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems

B. Related sections in other Divisions of Work:

1. Section 26 4113 - Lightning Protection for Structures

1.4 REFERENCES AND STANDARDS

A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:

1. United States Table of Frequency Allocations, current version
2. Federal Communications Commission Table of Frequency Allocations, current version
3. FCC 47 CFR Part 90.219
4. FCC OET Bulletin 65
5. IFC International Fire Code
6. NFPA 1: Fire Code
7. NFPA 72: National Fire Alarm and Signaling Code
8. NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems

1.5 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, following abbreviations and acronyms shall apply to this document:

1. ACG: Automatic Gain Control
2. AHJ: Authority Having Jurisdiction
3. ATP: Acceptance Test Plan
4. AWS: Advanced Wireless Service
5. BDA: Bi-Directional Amplifier
6. BOM: Bill-of-Material
7. BRS: Broadband Radio Service
8. BTS: Base Transceiver Station
9. CDMA: Code Division Multiple Access
10. C/N: Carrier-to-Noise Ratio
11. CWDM: Coarse Wave Division Multiplexing
12. DAS: Two-way Radio Communications Enhancement System
13. DAQ: Delivered Audio Quality
14. DWDM: Dense Wave Division Multiplexing
15. EBS: Educational Broadband Service
16. ESMR: Enhanced Specialized Mobile Radio
17. ERRC: Emergency Responder Radio Coverage
18. FCC: Federal Communications Commission
19. GUI: Graphical User Interface
20. iDEN: Integrated Enhanced Digital Network
21. LMR: Land Mobile Radio
22. LTE: Long Term Evolution
23. MIMO: Multiple-Input and Multiple-Output
24. MTBF: Mean Time Between Failure
25. NFPA: National Fire Protection Association
26. NMS: Network Management System
27. NTIA: National Telecommunications and Information Administration
28. PCS: Personal Communications System
29. PSE: Public Safety Entity
30. PSN: Public Safety Network
31. RF: Radio Frequency
32. RoF: Radio-over-Fiber

33. RoHS: Restriction of Hazardous Substances
34. RSL: Received Signal Level
35. RX: Receive
36. SISO: Single-Input, Single-Output
37. SMR: Specialized Mobile Radio
38. SMS: Short Message Service
39. SNIR: Signal-to-Noise Interference Ratio
40. SNMP: Simple Network Management Protocol
41. SOW: Statement of Work
42. TSL: Transmit Signal Level
43. TX: Transmit
44. VSWR: Voltage Standing Wave Ratio
45. WSP: Wireless Service Provider

1.6 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to this document:

1. Active: DAS components that require AC/DC power for operation
2. Carrier Approval: Expressed approval to interconnect to the WSP macro network
3. Channel: A path for an RF transmission between two points
4. Component: A main system element of the DAS
5. Contractor: The prime contractor bidding the project
6. Passive: DAS components that do not require AC/DC power for operation

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. In addition, Submit:

1. Initial RF site survey and analysis report, to include:
   a. Data collection point locations
   b. RF spectrum shots
   c. RF data plot maps

2. Floor plans documenting proposed coverage antenna locations
3. RF propagation modeling maps
4. SNIR maps
5. Link budget calculations, for both downlink path and uplink path
6. Maximum Permissible Exposure calculation documentation
   a. Prepared by independent third party

7. Documentation that each WSP and PSN has reviewed and approved proposed equipment and Contractor's design
8. Follow-up RF site survey and analysis report, to include:
   a. Data collection point locations
   b. RF spectrum shots
   c. RF data plot maps
   d. Documentation of changes to initial system design required due to results of follow-up RF site survey, where required, to include as applicable:
      1). Floor plans documenting proposed coverage antenna locations
      2). RF propagation modeling maps
      3). SNIR maps
      4). Link budget calculations, for both downlink path and uplink path
      5). Maximum Permissible Exposure calculation documentation
      6). Prepared by an independent third party
      7). Documentation that each WSP and PSN has reviewed and approved proposed equipment and Contractor's design

PART 2 - PRODUCTS

2.1 GENERAL

A. System shall be a BDA style turnkey system capable of integral support of RF signals for PSNs managed by FCC.

B. System shall support each PSN on each frequency currently being used by PSEs serving project area.

   1. Coordinate directly with each PSE prior to the commencement of design work to confirm frequencies active on the project's scheduled date of substantial completion.

C. System shall be expandable to support each frequency band allocated by FCC for PSN use, in a MIMO antenna environment without replacement of or addition to the system's passive infrastructure.

D. System shall be capable of receiving PSN AHJ approval.

E. System shall include filtering of all frequencies unused by PSN signals in area in which project is located.

F. System shall be capable of upgrade, without need for additional hardware or software, to support changes to other frequencies within deployed frequency bands to maintain PSN coverage as originally designed.

G. System shall be expandable to extend coverage for all Public Safety frequencies supported to future new additions without need for additional head end equipment.

H. Passive system components shall be:

1. Broadband
2. MIMO compatible
3. PIM (passive intermodulation) compliant

2.2 ANTENNAS

A. Broadband Donor Antenna

1. Antennas shall feature multi-band design accommodating applicable Public Safety frequencies in a single pole-mounted antenna.
2. Temperature range: -40°F to 140°F.
3. Rated for outdoor use.

B. Coverage Antennas – Omnidirectional

1. Antennas shall feature multi-band design accommodating multiple frequency bands in a single ceiling-mounted antenna
2. Antenna beam width:
   a. Horizontal: 360° omnidirectional
   b. Vertical: 65-80° nominal

3. Temperature range: -40°F to 140°F.
4. Rated for indoor use.

C. Coverage Antennas - Directional

1. Antennas shall feature multi-band design accommodating multiple frequency bands in a single wall-mounted antenna
2. Antenna beam width:
   a. Horizontal: 110° directional
   b. Vertical: 90° nominal

3. Temperature range: -40°F to 140°F.
4. Rated for indoor use.

2.3 BI-DIRECTIONAL AMPLIFIERS

A. Where BDA is used to drive DAS, BDA shall be modular design and use digital filtering to mitigate interference.

B. BDA shall be standard 19" rack or wall mountable.

C. BDA shall be able to individually control power level of each frequency band amplified.

2.4 CABLING

A. Feeder and riser cables shall be plenum rated.

PART 3 - EXECUTION

3.1 PSN SUPPORT COORDINATION MEETING

A. Prior to Contractor's design work commencement, Contractor shall arrange and conduct coordination meeting to review and coordinate Emergency Responder Radio Reinforcement system support of PSN frequencies.

1. At minimum, attendees shall include:
   a. AHJ and representatives of public safety entities utilizing supported PSN frequencies
   b. Owner's project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative
   c. Construction Manager/General Contractor project manager and site superintendent/field foreman
   d. Division 26 site superintendent/field foreman
   e. Division 27 project manager and site superintendent/field foreman
   f. Emergency Responder Radio Reinforcement subcontractor/supplier project manager

2. At minimum, meeting agenda topics shall include:
   a. Confirmation of PSN frequencies and channel loading currently being used by PSEs serving project area
   b. Identification of planned or potential changes in active frequencies and/or channel loading that may be implemented prior to scheduled date of substantial project completion
   c. Identification and discussion of proposed system's functional capabilities and limitations
   d. Step-by-step review of system design and deployment execution plan

e. Review of survey, design, installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.

3. Meeting shall be scheduled with minimum of two weeks' notice.
   a. Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.

4. Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

3.2 PRE-DESIGN SITE SURVEY

A. After specified coordination meetings and before completion of design, Contractor shall conduct pre-design site survey.

B. Data collection points shall:

1. Include potential donor antenna locations and elevations
   a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.

2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
3. Be sufficient in quantity and location to properly inform Contractor's design

C. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

3.3 DESIGN

A. Where DAS is used in lieu of a two-way in-building wired emergency communications system, DAS design shall be approved by AHJ.

B. Contractor is solely responsible for design of Emergency Responder Radio Reinforcement System.

C. Contractor shall design Emergency Responder Radio Reinforcement System in accordance with manufacturer's instructions and recommendations, industry standard best practices, and requirements of supported PSNs. Where discrepancies arise, more stringent requirement will govern.

D. Contractor shall design Emergency Responder Radio Reinforcement System to provide performance specified herein throughout the coverage areas and to meet approval of all supported PSNs.

E. Refer to Architectural drawings for building occupant information.

3.4 PRE-INSTALLATION SITE SURVEY

A. Contractor shall conduct pre-installation site survey no more than thirty (30) days prior to commencement of installation work on site to acquire updated measurement data.

1. Pre-installation site survey shall be conducted after walls are built and after glazing is installed.
2. Where pre-design site survey is conducted within thirty days of commencement of installation work and fulfills all requirements for both pre-design site survey and pre-installation site survey, separate pre-installation site survey is not required.

B. Data collection points shall:

1. Include potential donor antenna locations and elevations
   a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.

2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
3. Be sufficient in quantity and location to properly verify Contractor's design

C. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies
3. Continuous wave (CW) testing to validate propagation modeling

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

E. Contractor shall update their design as required by updated survey data.

3.5 WORK SEQUENCE

A. Coordinate schedule of Emergency Responder Radio Reinforcement system work to ensure Certificate of Occupancy is obtained in accordance with project schedule.

3.6 EQUIPMENT SUPPORTS

A. Donor Antenna Mounts

1. Donor antenna assemblies including antenna(s), antenna cable, antenna mount/mast, and associated accessories and hardware shall be designed and installed to withstand sustained winds of ≥ 100 miles per hour from any direction with all devices, equipment, and material installed and with up to 6 inches of radial ice accumulated.
2. Make donor antenna mounts/masts and associated components, accessories, and hardware electrically continuous and properly ground to lightning protection system. Refer to Section 26 4113 for conductor sizing and termination requirements, and for additional information and requirements.

3.7 INSTALLATION

A. Equipment Locations

1. Install donor antenna(s) in coverage areas.
2. Install main system head end equipment where indicated on drawings.
3. Install system floor-level equipment (splitters, directional couplers / taps, etc.) where indicated on drawings in telecommunications rooms. Refer to drawings for additional information.
4. Active system components, including transmitter, receiver, signal booster components, external filters and battery system components, shall be contained in NEMA 4 or 4X enclosures.

B. Power Supplies

1. Primary power source
   a. Emergency Responder Radio Reinforcement system active electronics shall be fed via minimum 20-amp emergency power electrical circuit(s), dedicated to Emergency Responder Radio Reinforcement system head end equipment.

2. Secondary power source
   a. System shall include battery back-up sufficient to power system at 100 percent system operation for minimum of twenty-four (24) hours.

3. Coordinate power requirements, quantities, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to commencement of work on site.

C. Cabling

1. Where DAS is used in lieu of two-way in-building wired emergency communications system, DAS shall have pathway survivability of Level 1, Level 2, or Level 3.
2. Riser cables shall be routed through 2-hour rated enclosure.
3. Connection between riser and feeder cables shall be made within 2-hour rated enclosure.
   a. Passage of feeder cable in and out of 2-hour rated enclosure shall be fire-stopped to 2-hour ratings.

D. Properly ground system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.

1. Refer to Section 27 0526 for additional information and requirements.

E. Provide and configure filtering to maximize composite power for PSN frequencies being supported.

F. Properly terminate unused RF ports on system devices, including amplifiers, splitters, directional coupler / taps, etc.

G. Donor Antennas

1. Coordinate donor antenna locations and mounting method with Architect and GC prior to rough-in.
2. Fasten donor antennas and associated mounting components. with stainless steel fasteners.
3. Bond donor antenna cables to ground at point where cable connects to antenna and at point where cable transfers off antenna mounting structure.
4. Provide in-line surge protection on antenna cables, at point where cable enters building.
   a. Properly ground surge protection components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.
   b. Refer to Section 270526 for additional information and requirements.

5. Weatherproof exterior antenna cable connections with manufacturer-approved assembly.

H. Coverage Antennas shall be installed in accessible ceilings or mounted to bottom of structure. Coordinate antenna locations with work by other trades to ensure that direct access to antenna is maintained after project completion.

I. System shall provide uniform coverage. Radio coverage shall be provided throughout building as percentage of floor area.

1. Critical areas, including fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by AHJ, shall be provided with 99 percent floor area radio coverage.
   a. General building areas shall be provided with 90 percent floor area radio coverage.

2. Minimum inbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Inbound signal level shall be sufficient to provide minimum of DAQ 3.0 for either analog or digital signals.
3. Minimum outbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Outbound signal level shall be sufficient to provide minimum DAQ 3.0 for either analog or digital signals.
4. Isolation shall be maintained between donor antenna and inside antennas to minimum of 20 dB under operating conditions.

J. System shall not interfere with operation of other electronic systems.

3.8 SYSTEM MONITORING

A. Fire Alarm System

1. System shall include automatic supervisory signals for malfunctions of emergency responder radio reinforcement system annunciated by fire alarm system in accordance with NFPA 72.
   a. Monitoring for system integrity shall comply with NFPA 72, Chapter 10.
   b. Provide visual and labeled indications for each supervised system component.
   c. System supervisory signals shall include:
      1). Donor antenna malfunction
      2). Active RF emitting device failure
      3). Low-battery capacity indication when 70 percent of the 24-hour operating capacity has been depleted
      4). System component failure
   d. Power supply supervisory signals shall include the following for each RF emitting device and system component:
      1). Loss of normal AC power
      2). Failure of battery charger
   e. Communications link between fire alarm system and emergency responder radio reinforcement system shall be monitored for integrity.

B. Dedicated Panel

1. Dedicated monitoring panel shall be provided within fire command center to annunciate status of RF emitting devices and system component locations. Monitoring panel shall provide visual and labeled indications of following for each system component and RF emitting device:
   a. Normal AC power
   b. Loss of normal AC power
   c. Battery charger failure
   d. Low battery capacity (to 70 percent depletion)
   e. Donor antenna malfunction
   f. Active RF emitting device malfunction
   g. System component malfunction

2. Communications link between dedicated monitoring panel and emergency responder radio reinforcement system must be monitored for integrity.

3.9 INSPECTION AND TESTING

A. Test plan shall include tests necessary to verify that installed system meets specified requirements and requirements of each PSE.

B. Scheduling

1. Testing shall be scheduled minimum of two weeks prior to scheduled date of final completion.
   a. Contractor shall coordinate with each PSE to arrange for them to observe system testing.

C. Data collection points

1. Data collection points shall include:

a. All donor antenna locations
b. Signal level at each stair landing and elevator lobby
c. Signal level at locations as required by AHJ

2. Be sufficient in quantity and location to properly verify that system's performance meets specified requirements and requirements of each PSE.
   a. At a minimum, each floor shall be divided into twenty equal areas and data shall be collected at or as near as is practical to the center of each area.

D. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies
3. Continuous wave (CW) testing
4. Signal strength of each supported PSN's system coverage signals, at all supported frequencies

E. At no additional cost to Owner, Contractor shall adjust, modify, and/or add to system as necessary to achieve performance required by AHJ.

3.10 ATTIC STOCK

A. Contractor shall provide following spare devices and equipment as Owner's attic stock:

1. Donor Antennas: One (1) of each type provided
2. Coverage Antennas: Five (5) of each type provided
3. Surge Suppressors: 100% of the quantity installed of each type provided.
4. Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.

3.11 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 4-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 275319

SECTION 280000 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This Section details references, standards, guidelines, requirements, conditions, etc. common to Division 28 work. Unless noted otherwise, work under related Division 28 Sections is subject to requirements of this Section.

B. Work under this Section and related Sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

C. Systems constituting the Division 28 scope of work include, but are not limited to:

1. Electronic Access Control
2. Video Surveillance

1.2 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete, turnkey systems which are furnished, installed, configured, tested, adjusted, and made completely ready for operation.

B. Contract documents are performance-based and diagrammatic, intended to convey the scope of work, design intent, and general arrangement of devices, equipment, etc. and define the minimum material quality, required features, operational requirements, and performance of the systems. Contract documents do not convey every required conductor, every required connection, or every required configuration or programming detail. Information provided in contract documents is as exact as could be secured but is not guaranteed. Contractor is solely responsible for determining devices, components, equipment, accessories, wiring, connections, terminations, configuration, programming, etc. to provide a complete and operational turnkey system that satisfies the scope of work and design intent conveyed.

C. Contractor is solely responsible for determination of quantities of equipment, devices, material etc. based on the information provided in the contract documents. Where discrepancies arise, the greater number shall govern.

D. Work related to Electronic Safety and Security in contract documents of other Divisions of Work shall be included as part of work under this Division.

E. If work and/or material, devices, equipment, etc. is depicted on the drawings, required in the specifications, specified in other contract documents, or necessary for proper operation and satisfying the scope of work and design intent conveyed, it shall be considered part of this contract. Contractor shall include in their bid costs associated with the work and material, devices, equipment, etc. depicted on the drawings, required in the specifications, specified in other contract documents, and necessary for proper operation and satisfying the scope of work and design intent conveyed.

F. Prior to submitting a bid, Contractor shall notify the Architect/Engineer of necessary work the Contractor believes to be omitted from the Contract Documents, and of products specified the Contractor believes to be improper or inadequate.

1.3 RELATED WORK

A. Related Division 28 Sections include:

1. Section 28 1000 - Electronic Access Control
2. Section 28 2000 - Video Surveillance

B. Related Divisions of Work and related sections in other Divisions of Work:

1. Division 01 - General Requirements
   a. Section 01 5000 - Temporary Facilities and Controls
   b. Section 01 524 - Construction Waste Management

2. Division 02 - Existing Conditions
   a. Section 02 4100 - Demolition

3. Division 03 - Concrete
4. Division 06 - Wood, Plastics, and Composites
   a. Section 06 1000 - Rough Carpentry

5. Division 07 - Thermal and Moisture Protection
   a. Section 07 8400 – Firestopping
   b. Section 07 9200 – Joint Sealants

6. Division 08 - Openings
7. Division 09 - Finishes
8. Division 10 - Specialties
9. Division 11 - Vehicle and Pedestrian Equipment
10. Division 12 - Furnishings
    a. Section 12 5900 - Systems Furniture

11. Division 14 - Conveying Equipment
    a. Section 14 2000 - Elevators

12. Division 21 - Fire Suppression
12. Division 22 - Plumbing
13. Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)
14. Division 25 - Integrated Automation
15. Division 26 - Electrical
    a. Section 26 0526 - Grounding and Bonding for Electrical Systems
    b. Section 26 0529 - Hangers and Supports for Electrical Systems
    c. Section 26 0533 - Raceway and Boxes for Electrical Systems
    d. Section 26 0533.13 - Surface Raceway System
    e. Section 26 0536 - Cable Trays for Electrical Systems
    f. Section 26 0539 - Underfloor Raceways for Electrical Systems
    g. Section 26 0543 - Underground Ducts and Raceways for Electrical Systems
    h. Section 26 0543.19 - Manholes and Hardware
    i. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems

j. Section 26 0553 - Electrical Systems Identification
k. Section 26 0593 - Electrical Systems Firestopping
l. Section 26 3353.13 - Static Uninterruptible Power Supply

16. Division 27 - Communications
    a. Section 27 0526 - Grounding and Bonding for Communications Systems
    b. Section 27 0528.29 - Hangers and Supports for Communications Systems
    c. Section 27 0528.33 - Raceway and Boxes for Communications Systems
    d. Section 27 0528.36 - Cable Tray for Communications Systems
    e. Section 27 0528.39 - Surface Raceways for Communications Systems
    f. Section 27 0553 - Communications Systems Identification
    g. Section 27 1000 - Structured Cabling
    h. Section 27 1100 - Communications Equipment Room Fittings
    i. Section 27 1300 - Communications Backbone Cabling
    j. Section 27 1500 - Communications Horizontal Cabling
    k. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

17. Division 31 - Earthwork

C. Refer to individual technical sections identified above for additional related sections.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State, and local authorities and of utility companies serving the project site in force at time of execution of contract shall become part of this specification.

B. Perform work in accordance with laws, codes, regulations, ordinances, etc. of the jurisdiction in which the project site is located and in accordance with Owner's published standards.

C. Perform work in accordance with referenced standards, guidelines, and industry best practices.

D. Perform work in accordance with manufacturer's instructions, guidelines, recommendations, etc.

E. Where a discrepancy exists between laws, codes, regulations, ordinances, guidelines, industry best practices, Owner's published standards, manufacturer's instructions, manufacturer's guidelines, manufacturer's recommendations, etc. and contract documents, the most stringent requirement or direction that complies with laws, codes, regulations, and ordinances shall govern.

F. Changes to work conveyed by the contract documents made after the letting of the contract to comply with applicable laws, codes, regulations, ordinances, Owner's published standards, or contract documents or to comply with the requirements of the Authority Having Jurisdiction shall be made by the Contractor without any cost to the Owner.

G. Contractor shall include in their bid costs to procure permits, licenses, approvals, etc. applicable to work performed, including:

    1. Costs to prepare documents for applications, submittals, etc. for review by Authority Having Jurisdiction
    2. Application, submittal, etc. charges, fees, taxes, etc.

H. Contractor shall include in their bid costs for inspections of work performed related to permits, licenses, approvals, etc. or laws, codes, regulations, ordinances, or Owner's published standards.

1.5 REFERENCES AND STANDARDS

A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:

1. Local Electrical Code
2. Country, state and local health, safety and building codes
3. Americans with Disabilities Act
4. ADA Standards for Accessible Design
5. ANSI/ASIS PAP.1-2012 - Security Management Standard: Physical Asset Protection
6. ANSI/ASIS SPC.1-2009 - Organizational Resilience: Security, Preparedness, and Continuity Management Systems - Requirements with Guidance for Use
7. ANSI/IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
8. ANSI/IEEE 1100: Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
9. ANSI/IEEE C2: National Electrical Safety Code
10. ANSI/TIA-606-C: Administration Standard for Telecommunications Infrastructure
11. ANSI/TIA-607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises Standard
12. ANSI/TIA-4966: Telecommunications Infrastructure Standard for Educational Facilities
13. ANSI/TIA-5017: Telecommunications Physical Network Security Standard
14. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
15. ASTM E-814: Standard Test Method for Fire Tests of Through-Penetration Firestops
16. ICC International Building Code
17. ICC International Fire Code
18. IEEE 81: IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
19. IEEE 802.3af and 802.3at: Power-over-Ethernet Standards.
20. IEEE 802.3an: 10 Gigabit Standard
21. IEEE 837: Standard for Qualifying Permanent Connections Used in Substation Grounding.
22. NFPA 70: National Electrical Code
23. NFPA 101: Life Safety Code
24. NFPA 780: Standard for the Installation of Lightning Protection Systems
25. NECA/BICSI 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
26. TIA TSB-184: Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
27. TIA TSB-185: Environmental Classification (MICE) Tutorial
28. TIA TSB-190: Guidelines on Shared Pathways and Shared Sheaths
29. UL 94: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
30. UL 96 - Lightning Protection Components
31. UL 96A - Installation Requirements for Lightning Protection Systems
32. UL 294 - Standard for Access Control System Units
33. UL 294B - Standard for Power Over Ethernet (PoE) Power Sources for Access Control Systems and Equipment
34. UL 365 - Standard for Police Station Connected Burglar Alarm Units and Systems
35. UL 444: Communications Cables
36. UL 467: Electrical Grounding and Bonding Equipment
37. UL 603 - Standard for Power Supplies for Use with Burglar-Alarm Systems
38. UL 609 - Standard for Local Burglar Alarm Units and Systems
39. UL 634 - Standard for Connectors and Switches for Use with Burglar-Alarm Systems

40. UL 636 - Standard for Holdup Alarm Units and Systems
41. UL 681 - Standard for Installation and Classification of Burglar and Holdup Alarm Systems
42. UL 723 - Surface Burning Characteristics of Building Materials
43. UL 827 - Standard for Central-Station Alarm Services
44. UL 910 - Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
45. UL 1034 - Standard for Burglary-Resistant Electric Locking Mechanisms
46. UL 1037 - Standard for Antitheft Alarms and Devices
47. UL 1076 - Standard for Proprietary Burglar Alarm Units and Systems
48. UL 1479 - Fire Tests of Through-Penetration Firestops
49. UL 1610 - Standard for Central-Station Burglar-Alarm Units
50. UL 1635 - Standard for Digital Alarm Communicator System Units
51. UL 1666 - Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
52. UL 2044 - Standard for Commercial Closed-Circuit Television Equipment
53. UL 2079 - Tests for Fire Resistance of Building Joint Systems
54. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

B. Design, cable and component selection, and installation practices shall also conform with additional standards identified in individual Technical Sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Agencies or publications referenced herein refer to the following:

1. ANSI American National Standards Institute
2. ASIS American Society of Industrial Security
3. ASME American Society of Mechanical Engineers
4. ASTM American Society for Testing and Materials
5. BICSI Building Industry Consulting Services International
6. EIA Electronic Industries Alliance
7. FIPS Federal Information Processing Standards
8. FCC Federal Communications Commission
9. ICEA Insulated Cable Engineers Association
10. IEEE Institute of Electrical and Electronics Engineers
11. NEC National Electrical Code
12. NECA National Electrical Contractors Association
13. NEMA National Electrical Manufacturers Association
14. NESC National Electrical Safety Code
15. NETA National Electrical Testing Association
16. NFPA National Fire Protection Association
17. NIST National Institute of Standards and Technology
18. OSHA Occupational Safety and Health Administration
19. TIA Telecommunications Industry Association
20. UL Underwriters Laboratories, Inc.

B. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
2. AFF Above Finished Floor
3. ATM Asynchronous Transfer Mode

4. AWG American Wire Gauge
5. BAS Building Automation Systems
6. BTU British Thermal Unit
7. °C degrees Celsius
8. CATV Community Antenna Television
9. CCTV Closed-Circuit Television
10. CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
11. cm centimeters
12. CM Communications cable rated for General Purpose use
13. CMP Communications cable rated for use in Plenum areas
14. CMR Communications cable rated for use in Risers and vertical runs
15. CP Consolidation Point
16. DTMF Dual Tone Multi Frequency
17. EIA Electronic Industries Alliance
18. EF Entrance Facility
19. ELFEXT Equal-Level Far-End Cross Talk (pair-to-pair)
20. ER Entrance Room
21. EIDF Equipment Intermediate Distribution Facility
22. °F degrees Fahrenheit
23. FDDI Fiber Distributed Data Interface
24. FEXT Far-End Cross Talk
25. ft. feet
26. F/UTP Foiled Unshielded Twisted Pair
    No shielding around individual pairs and an overall foil shield under the cable jacket
27. GbE Gigabit Ethernet
28. HC Horizontal Cross-connect
29. HCP Horizontal Connection Point (e.g. for TIA-862)
30. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
31. ID Inside Diameter
32. IDF Intermediate Distribution Frame
33. in inch
34. IPT IP Telephony
35. kg kilogram
36. lbs. pounds
37. LAN Local Area Network
38. MATV Master Antenna Television
39. MC Main Cross-connect
40. MDF Main Distribution Frame
41. m meters
42. mm millimeters
43. Mbps Megabits per second
44. µm micrometer (10^{-6} meter)
45. N Newton
46. NEXT Near End Cross Talk
47. OD Outside Diameter
48. OFNP Optical Fiber Nonconductive Plenum
49. OFNR Optical Fiber Nonconductive Riser
50. OTDR Optical Time Domain Reflectometer
51. PBX Private Branch Exchange (Telephone Switch)
52. pF pico-Farad (10^{-12} Farad)
53. PoE Power-over-Ethernet

54. PSNEXT Power Sum Near End Cross Talk
55. PVC Polyvinyl Chloride
56. RU Rack Unit
57. S/FTP Screened Foiled Twisted Pair
    (Individual foil shield around each individual pair and an overall braided shield under the cable jacket.)

58. SF/UTP Screened Foiled Unshielded Twisted Pair
    (No shielding around individual pairs and overall foil and braided shields under the cable jacket.) sq. ft. square feet (area)

59. S/UTP Screened Unshielded Twisted Pair
    (No shielding around individual pairs and an overall braided shield under the cable jacket.)

60. TO Telecommunications Outlet
61. TP-PMD Twisted Pair Physical Layer Medium
62. TR Telecommunications Room
63. U/FTP Unshielded Foiled Twisted Pair
    (Individual foil shield around each individual pair and no overall braided shield under the cable jacket.)

64. UTP Unshielded Twisted Pair
    (No shielding around pairs nor overall under cable jacket.)

65. USOC Universal Service Order Code
66. VoIP Voice over Internet Protocol
67. WAN Wide Area Network
68. WLAN Wireless Local Area Network

C. Refer to technical sections for additional terminology.

1.7 DEFINITIONS

A. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 28 contract documents shall have the following meanings:

1. "Provide" shall mean "furnish, install, configure, test, adjust, etc. and make completely ready for operation".
2. "Furnish" does not include installation, configuration, testing, adjusting, etc.
3. "Install" shall mean “install, configure, test, adjust, etc. and make completely ready for operation” but does not include furnishing.

B. Acceptance: Expressed approval

C. The following definitions are applicable to Electronic Safety and Security environments and shall apply to this document and its companion sections for clarification and direction.

1. Auxiliary Intelligent Controllers (AIX) or Auxiliary I/O Controllers (AIO). Controllers that are located near a served access control door and not in the Master Intelligent Controller Location.

2. CCTV: Closed-circuit television/Video Surveillance
3. CPU: Central processing unit.
4. Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
5. Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
6. Contractor: Electronic Safety and Security Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of Electronic Safety and Security equipment, devices, cabling, pathway hardware, equipment room hardware, and related components detailed in technical sections of this Division of work.
7. Credential: Data assigned to an entity and used to identify that entity.
8. Equipment Room (Security): an environmentally controlled centralized space for Electronic Safety and Security equipment that usually houses head end equipment, servers, control panels, power supplies, and system cabling terminations.
9. GFI: Ground fault interrupter.
10. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
11. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
12. Intra-building - within single building.
13. Intelligent Controller: An access control controller containing a database of cardholders and system operation parameters that allow it to operate independently from the system Server when the communications between the Server and the Intelligent Controller is not available.
14. Inter-building - between 2 or more buildings.
15. Intra-building - within single building.
16. I/O controllers: Input/Output controllers that provide a wiring interface to field devices,
17. LAN: Local area network.
18. Master Intelligent Controller (MIC). An intelligent controller that connects to Auxiliary Intelligent Controllers or Auxiliary I/O controllers I/O controllers over TCP/IP or EIA-485 communications networks.
19. Location: A Location in the building having a Master or Auxiliary Intelligent Controller. Where this term is presented with an initial capital letter, this definition applies.
20. PC: Personal computer. Applies to the, main and auxiliary workstations.
21. Proximity Card: Magnetic principle that uses specially treated wires embedded in the credential card.
22. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.
23. RF: Radio frequency.
24. ROM: Read-only memory. ROM data are maintained through losses of power.
25. Server: Computer configured as an access control system application and file server.
26. Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.
27. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
28. UPS: Uninterruptible power supply.
29. USB: Universal serial bus.
30. WAN: Wide area network.
31. WAV: The digital audio format used in Microsoft Windows.
32. WMP: Windows media player.
33. Wiegand: Cable and signal protocol

34. Windows: Operating system by Microsoft Corporation.
35. Workstation: A PC with software that is configured for specific, limited security-system functions.

D. Typical NEMA Enclosures and Usage

1. Refer to Section 26 0000 – General Electrical Requirements.

1.8 WORK BY OWNER

A. Owner will provide:

1. Telecommunications service, including voice and data / internet
2. Active telephone equipment, including analog/digital/VoIP private branch exchange (PBX), telephones, fax machines, and modems
3. Active Ethernet networking equipment, including modems, routers, firewalls, switches, wireless Ethernet access points
4. Active office equipment, including server computers, data storage appliances, workstation computers, scanners, and printers
5. Electronic access control credentials

1.9 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

B. Products

1. Only products of reputable manufacturers, as determined by the Architect/Engineer, will be acceptable. Manufacturers shall have a minimum of five (5) years of documented experience in designing, manufacturing, delivering, and supporting the specified material.
2. Where contract documents require a product, material, or assembly that hasn't been specified by brand or trade name, provide product, material, or assembly that meets the specified requirements, as supplied and warranted by the system vendor. If system vendor does not offer product, material, or assembly, provide product, material, or assembly per system vendor's recommendation.

C. Contractor

1. Contractors shall have a minimum of five (5) years' documented experience providing and servicing the specified equipment, devices, components, materials, and systems.
2. Contractor shall have documented history of successfully completing a minimum of three (3) projects of a scope and magnitude equal to or greater than that specified in the Contract Documents.
3. Contractor shall have a minimum of five (5) years' documented history of being continuously current on manufacturer's training and certifications applicable to the specified equipment, devices, components, materials, and systems they propose for use on the project.
4. Contractor shall have a minimum of five (5) years' documented history of being certified by the manufacturer to offer and support manufacturer warranties applicable to the specified

equipment, devices, components, materials, and systems they propose for use on the project.

5. Contractor's staff assigned as project manager, site superintendent, and foreman shall each have documented history of successfully completing a minimum of three (3) projects of a scope and magnitude equal to or greater than that specified in the Contract Documents.
6. Contractor's staff assigned as site superintendent and foreman and Contractor's staff assigned to perform installation, termination, configuration, programming, and testing shall have a minimum of five (5) years' documented experience of being continuously, individually certified by the manufacturer on the specified equipment, devices, components, materials, and systems proposed and approved for use on the project.
7. Contractor shall have an in-house service department staffed with technicians who are individually manufacturer-certified to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on the project, and who are equipped with tools, equipment, materials, etc. necessary to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on the project.
    a. Contractor's in-house service division/department/staff shall offer maximum 8-hour on-site service call response time 24 hours a day, 7 days a week, 365(6) days a year.
8. Contractors and subcontractors shall only employ workers who are properly trained to execute the work being performed and are skilled in their trade.
9. Contractors and subcontractors shall own and maintain equipment, tools, etc. to execute the work performed in a manner consistent with laws, codes, regulations, ordinances, standards, guidelines, industry best practices, manufacturer's instructions, etc.. Workers shall be properly trained in the use of equipment, tools, etc. necessary for them to complete the work performed.
10. Contractor shall submit with shop drawings documentation of compliance with requirements listed above. Inability to demonstrate compliance with requirements listed above shall disqualify Contractor from self-performing the work conveyed by the contract documents, and Contractor shall then, at no additional cost to Owner, subcontract with another firm qualified to perform the work.

1.10 SUBMITTALS

A. General:

1. Refer to Division 01 for additional information and requirements.
2. Refer to individual technical sections for additional information and requirements.
3. Submittals shall be prepared and submitted in electronic form and/or in printed hard copy form per Division 01.
    a. Unless noted otherwise, documents submitted in electronic form shall be in .pdf format.
        1). Electronic files shall be submitted on USB flash drive storage media.
    b. Unless noted otherwise, documents submitted in printed hard copy form shall be printed directly from electronic files and shall be clearly legible.
        1). Submittals including illegible hard copy sheets will be rejected in their entirety and returned for resubmittal without review.

B. Shop Drawings:

1. The Owner reserves the right to make changes to descriptive information, component selection and nomenclature during shop drawing review without incurring and additional cost.
2. Note that for satisfying submittal requirements for Division 28, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the term "Shop Drawings" is generally used throughout specification.
3. Submit shop drawings or product data as soon as practicable after execution of contracts. Submittals must be approved before materials are ordered, delivered to site, or installed.
4. Documents submitted in printed hard copy form shall be original catalog sheets or sheets printed from manufacturer-issued electronic .pdf files and shall be clearly legible.
5. Group submittals by Specification Section to include complete documentation of related systems, products and accessories. Submittals for systems, assemblies, etc. consisting of more than one item, component, etc. shall be made for the system or assembly as a whole. Partial submittals for such systems, assemblies, etc. will be rejected in their entirety and returned for resubmittal without review.
    a. Printed hard copy submittals, where applicable, shall be bound in a three-ring binder with index tab dividers separating submitted materials by Specification Section, system, sub-system, and major pieces of equipment.
        1). Provide multiple three-ring binders where necessary to ensure that no binder is larger than 2” in ring size.

6. Provide a table of contents for each Specification Section, to include each item being submitted. Each table of contents entry shall include:
    a. Nomenclature applied in the specifications and/or on the drawings to describe the item (e.g., “18/2 Unshielded Cable”)
    b. Manufacturer and part number, where applicable
    c. Reference to Specification Section or drawing where item is specified (e.g., “280000 - 1.10 - B - 6 - c” or “Drawing T000”)

7. Prepare submittals to include information required to demonstrate understanding of and compliance with requirements of the contract documents.
    a. Where submitted information does not demonstrate compliance with requirements of the contract documents, discrepancies shall be so noted and an explanation for the discrepancy shall be provided.

8. Provide documentation demonstrating compliance with requirements specified in 280000 - 1.9 - Quality Assurance above.
9. Provide manufacturer’s product data for each item, component, device, and material proposed for the system. At a minimum, the data submitted shall clearly demonstrate compliance with each requirement specified in the contract documents.
    a. Submitted product data shall include electrical power consumption, BTU output, contact ratings, and wiring diagrams for electrically powered or controlled equipment.
    b. Where equipment and items specified include components, parts, sub-assembiles, accessories, additional items, etc. under one designation, submittals shall be complete and include required components.
    c. Where accessories, peripheral materials, consumables, additional items, etc. are required to provide the specified performance and functionality or to facilitate installation, submittals shall be complete and include such items.
    d. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.

e. Where obtaining a proposed item, component, device, or material involves a lead time of more than ten (10) working days, Contractor shall note the lead time quoted by the distributor, supplier, or vendor and provide an explanation of factors contributing to the lead time.
f. Manufacturer's product data sheets submitted shall be original full color versions of those documents. Black and white or greyscale versions of documents originally issued by the manufacturer in full color will be rejected in their entirety and returned for resubmittal without review.
g. Where manufacturer's product data sheets include multiple part numbers, mark the sheets to indicate specific items being submitted.
   1). Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
   2). Where product data includes multiple product options, mark proposed option(s).
h. Mark manufacturer's product data sheets with nomenclature applied in the specifications and/or on the drawings to describe the item (e.g., "18/2 Unshielded Cable")
i. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item and explanation for the discrepancy.
j. Where applicable, dimensions shall be marked in units to match those specified.

10. Provide CAD-generated, scaled, project-specific floor plan drawings for each discrete system, depicting equipment, device, component, etc. locations and main system cabling pathway routes.
    a. Drawings shall be Contractor-generated. Submitting copies of bid or construction documents is not an acceptable means of fulfilling this requirement.
    b. Drawings shall include legends defining symbols, abbreviations, etc. used in the diagrams.

11. Provide CAD-generated, scaled, project-specific equipment room layout drawings for each equipment room, depicting size and layout of equipment, raceways, accessories, working clearances, etc.
    a. Drawings shall be Contractor-generated. Submitting copies of bid or construction documents is not an acceptable means of fulfilling this requirement.
    b. Drawings shall include legends defining symbols, abbreviations, etc. used in the diagrams.

12. Provide for each system a CAD-generated project-specific system block diagram that clearly depicts system components and wiring, including proposed type and size of each conductor, and clearly illustrates system topology, interconnections between system components, location of major system equipment, and integration interconnections between otherwise discrete systems.
    a. Where system includes multiple instances of an identical component or device in an identical configuration, diagram may depict a single, typical instance of that component or device labeled as typical, so long as doing so does not negatively impact the diagram's ability to effectively convey pertinent system information in a complete manner. Architect/Engineer will make final determination on whether a "typical" depiction is acceptable.
    b. Diagrams shall depict used and unused/spare input and output connection points on equipment, devices, components, etc.
    c. Diagrams shall depict equipment, device, component, etc. connections to electrical power sources.
    d. Diagrams shall include legends defining symbols, abbreviations, etc. used in the diagrams.

e. Diagrams shall be Contractor-generated. Copies of Contract Documents shall not fulfill this requirement and will be rejected in their entirety and returned for resubmittal without review.
f. Diagrams shall be project-specific. Generic diagrams shall not fulfill this requirement and will be rejected in their entirety and returned for resubmittal without review.

13. Provide for each piece of equipment, device, component, etc. CAD-generated installation details, to include mounting, termination, configuration, etc. information.
    a. Where project conditions dictate installation or mounting unique to the project, such installation details shall be Contractor-generated and project specific. In these instances, generic details shall not fulfil this requirement and will be rejected in their entirety and returned for resubmittal without review.
    b. Details shall include legends defining symbols, abbreviations, etc. used in the diagrams.

14. Provide for each discrete system documentation of power supply, battery charger, and battery calculations.
15. Provide for each discrete system documentation of voltage drop calculations for electrical power wiring ≥ 25 feet in length transmitting low-voltage power from system power supplies to system devices or components.
16. Provide documentation of proposed labeling scheme, to include:
    a. Logic of alphanumeric identifiers for each component type
    b. Proposed font/typeface
    c. Samples of each proposed label type (e.g., cable wrap, device, control panel, etc.)
        1). Samples shall be actual labeling products typical of those proposed for use on the project, including proposed font type, size, and print quality.
        2). Affix each submitted proposed label type to a sheet of backing paper. Backing paper color shall provide contrast with the proposed labels to aid in making physical outline of labels clear on scanned electronic copies, and include identification of specific use each label type is proposed for (e.g., cable wrap, device, control panel, etc.).

17. Provide documentation of proposed testing procedures, to include:
    a. List of codes, standards, and guidelines referenced to develop test procedure
    b. Equipment proposed for use in testing, to include:
        1). Manufacturer's product data for each unit
        2). Documentation demonstrating date of most recent calibration for each unit
        3). Step-by-step procedure for configuring unit to perform proposed tests
        4). Documentation demonstrating that workers are trained and certified on each unit
    c. Step-by-step description of proposed test procedure
    d. Pass/fail criteria for each test
    e. Sample of each proposed test result documentation format. At a minimum, test result documentation shall include:
        1). Project information
            a). Owner
            b). Building name
            c). Location
            d). Project name
        2). Date and time of test(s)
        3). Name of the Contractor conducting the test(s)
        4). Name(s) and title(s) of personnel conducting the test(s)
        5). Test equipment type, manufacturer, model number, and serial number

6). Test equipment calibration reference and test setup
7). Test equipment configuration (e.g., frequencies tested, wavelengths tested, etc.)
8). Pass/fail criteria
9). Description of sub-system tested
10). Unique alphanumeric identifier assigned to cable, device, etc. under test
11). Identification of Communication Equipment Room where cable originates or location of associated system head end equipment
12). Equipment location and direction of test, where applicable
13). Test result data
14). Signature of personnel who conducted the test

f. Proposed test documentation file naming format

18. Provide sample of proposed attic stock inventory documentation. Inventory shall include for each item provided:
    a. Manufacturer name
    b. Manufacturer part number
    c. Item name
    d. Item description
    e. Quantity provided

19. Provide documentation of proposed training curriculum, to include:
    a. Detailed agenda for each training session
    b. Example support and reference materials for each training session
    c. Documentation demonstrating that proposed instructor is qualified to provide the proposed training and has relevant experience providing the proposed training.

20. Contractor shall review prepared shop drawings internally for compliance with requirements of the project documents and make any alterations necessary to ensure compliance. Contractor shall stamp the cover page of each shop drawing section submitted to certify that this internal review was completed and necessary alterations were made to ensure compliance with requirements of the project documents prior to submitting the shop drawings for review.
21. Submittals which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
22. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that required items have been submitted.
23. Engineer's approval of submitted shop drawings does not relieve the Contractor from having to comply with requirements of the Contract Documents.
24. Work on site shall not proceed prior to approval of shop drawings related to that work.

C. Certificates and Inspections:

1. Deliver certificates approving installations to Owner unless otherwise directed.

D. Operation and Maintenance Documents:

1. Upon completion of work but before final acceptance of system, submit to Architect for approval, one (1) printed copy of operation and maintenance manuals in three-ring binders and one (1) electronic copy of operation and maintenance manuals in .pdf format. After securing approval, submit quantity of printed and electronic copies of final operation and maintenance manuals to Owner per Division 01.

2. Manuals shall be prepared and organized in the same manner as Shop Drawings as specified above.
3. At a minimum, manuals shall include the following:
    a. Contact information for Contractor and Subcontractors involved in the execution of the specified work:
        1). Names of:
            a). Estimator(s)
            b). Project Manager(s)
            c). Field Superintendent(s)
            d). Field Foreman(Foremen)
            e). System Programmer(s)
            f). Test Technician(s)
        2). Street address
        3). Mailing address
        4). Main voice phone number
        5). Direct-dial voice phone numbers for:
            a). Project Manager(s)
            b). Field Superintendent(s)
            c). Field Foreman(Foremen)
        6). General fax phone number
        7). Internet/web page address
        8). Direct email addresses for:
            a). Project Manager(s)
            b). Field Superintendent(s)
            c). Field Foreman(Foremen)
    b. Contact information for each manufacturer and supplier or distributor of products provided:
        1). Name of primary service contact
        2). Street address
        3). Mailing address
        4). Main voice phone number
        5). Direct-dial voice phone number for primary contact
        6). Fax phone number
        7). Internet/web page address
        8). Direct email address for primary contact
    c. Contact information for manufacturer-certified service entity local to the project site, for each product provided:
        1). Name of primary service contact
        2). Street address
        3). Mailing address
        4). Main voice phone number
        5). Direct-dial voice phone number for primary contact
        6). After-hours service voice phone number
        7). Fax phone number
        8). Internet/web page address
        9). Direct email address for primary contact
        10). After-hours service email address
    d. Copies of approved shop drawings, including Architect/Engineer review and approval forms.
    e. Final manufacturer’s product data for each item, component, device, material, etc. that constitutes the installed system, incorporating any deviations from approved manufacturer’s product data submittal and reference to project documentation that initiated the deviation.

f. Manufacturer-published installation instructions, configuration and programming instructions, owner's manuals, and operation and maintenance instructions:
   1). Where manufacturer's data includes several types or models, applicable type(s) or model(s) shall be designated.
   2). Include parts lists for equipment, devices, etc., including ordering and procurement information. Provide exploded parts lists where available.
   3). Operation and Maintenance manuals shall not include duplicate product data within materials for a single Specification Section.

g. Documentation of firmware, software, and Ethernet network information for each IP system device, component, equipment, etc., to include:
   1). Unique alphanumeric identifier
   2). Location
   3). Manufacturer
   4). Manufacturer's part number
   5). Serial number
   6). Firmware version
   7). MAC address
   8). IP address
   9). Subnet mask
   10). Default gateway
   11). TCP port numbers for active inbound and outbound connections
   12). UDP port numbers for active inbound and outbound connections
   13). Unique alphanumeric identifier of Ethernet network switch serving the device
   14). Ethernet network switch port number
   15). VPN assignment
   16). VLAN assignment
   17). Requires IP multicast functionality (yes/no)

h. Documentation that ownership of software and programming has been transferred to Owner.

i. Documentation of product-related licenses, including documentation that licenses have been transferred to Owner.

j. Documentation of login and password information.

k. Factory and field test result documentation, in format of approved test result documentation submittal.
   1). Test results shall be submitted in .pdf electronic format and in native file format of test equipment, where applicable.
      a). Where equipment-specific software is required to inspect test result files provided in native file format of test equipment, Contractor shall provide at no additional cost one (1) full version of equipment-specific software required to open and inspect test result files.

l. Documentation of manufacturer's warranties.

m. Documentation of Contractor's warranty.

n. Training materials.

4. Refer to individual technical Sections for additional Operation and Maintenance manual requirements.
5. O&M manuals and instructions to Owner shall be provided prior to request for final payment.
6. O&M materials shall become the property of the Owner.

E. Record Drawings:

1. Provide final floor plans, equipment room layouts, block diagrams, and installation details incorporating any deviations from approved submittal and reference to project documentation that initiated the deviation. Documents shall include final unique alphanumeric identifiers for each item as so labeled.
2. Record Drawing materials shall become the property of the Owner.

F. Review and approval of submitted documents does not relieve Contractor of contractual obligations, alter work specified in the contract documents, alter requirements of the contract documents, or void requirements of the contract documents.

1.11 WARRANTY

A. Refer to Division 01 for general Warranty requirements.

B. Refer to technical sections for Warranty requirements specific to the work under that section. Unless specified otherwise in Division 01 or in a technical section:

1. The warranty period shall commence on the date of final acceptance by Owner and extend for a minimum of one (1) year.
   a. Where manufacturer offers a standard warranty that extends beyond one (1) year, the published duration of the manufacturer warranty shall govern for material covered by that warranty.

2. The warranty shall guarantee work performed and materials, devices, equipment, etc. provided to be free from defect or malfunction.

C. Manufacturer's guarantees and/or warranties shall extend to the Owner.

D. Contractor shall, at Owner's sole option, repair, replace, or correct defective material and workmanship and material and workmanship that does not conform to the contract documents, at no extra cost to Owner. Contractor shall also bear costs to correct damage resulting from defective or nonconforming materials and/or workmanship.

E. Warranty does not cover defect or malfunction that is solely the result of normal wear, improper maintenance, or improper operation, as determined by the Architect/Engineer.

F. Where Contractor disturbs any work warranted under another contract while fulfilling requirements of any warranty, Contractor shall restore such disturbed work to condition satisfactory to Architect/Engineer and Owner and shall warrant such restored work to same extent as it was warranted under such other contract.

G. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide new materials, unless specifically noted otherwise in the contract documents.

B. Where manufacturer has replaced a part number with a newer part number, provide the version of the material that is the manufacturer's most current offering available at the time of installation.

C. Where manufacturer has published an end of life or similar notice for a part number, notify the Architect/Engineer of the notification and the manufacturer's recommended substitution. Where manufacturer offers no substitution, provide the Architect/Engineer three (3) options for acceptable alternates.

D. Where multiple manufacturers' names or manufacturers' names and part numbers are listed, the basis of design listed is to be considered the benchmark for quality, features, and functionality for that material.

E. Include hardware, details, options, modules, accessories, subassemblies, etc. not shown or specified, but necessary for proper installation and operation.

F. Where ≥ one (1) of the same item of material is required, all such units shall be provided as the same manufacturer and part number.

G. Refer to technical sections for additional information and requirements.

2.2 LISTING

A. Materials shall bear UL label or listing, unless UL label or listing is not available for that type of material. Where a nationally recognized testing laboratory has an applicable system listing and label, the entire system shall be so listed and labeled.

1. Other nationally recognized testing agencies acceptable to the AHJ are approved.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Refer to technical sections of this Division of work for listing requirements.

2.3 PRODUCT SUBSTITUTIONS

A. Refer to Division 01.

B. Unless noted otherwise, Contractor may choose to propose equivalent material from another manufacturer. Where Contractor chooses to propose other material they believe to be equivalent, Contractor is solely responsible for ensuring that the alternate material is demonstrably equivalent to the listed basis of design, meets requirements specified in the project documents for that material, and fits in the allocated space. Contractor shall submit alternate material for approval in accordance with requirements of Division 01 and of this Section, and Architect/Engineer shall make the final determination as to whether the proposed alternate material is equivalent and acceptable for use on the project.

PART 3 - EXECUTION

3.1 GENERAL

A. Execute work to minimize interference, annoyance, or inconvenience such work might impose on Owner or other contractors.

B. Work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

C. Include incidental items and details that are not depicted on the drawings, required in the specifications, or specified in other contract documents but are necessary for proper installation, operation, and satisfying the scope of work and design intent conveyed.

3.2 OWNER INSPECTION

A. Owner shall, at their sole option, observe, inspect, review, and approve work in progress throughout the execution of work on site.

B. Coordinate scheduling of the following with Owner a minimum of ten (10) working days prior to commencement of the listed activity, to facilitate Owner's observation, inspection, review, and approval of work:

1. First device rough-in and cable pathway installation
2. First cable installation
3. Placement of equipment racks and cabinets, prior to final installation
4. Placement of wall-mounted equipment, prior to final installation
5. Installation of cable runway in Communication Equipment Rooms
6. First cable termination
7. First system device testing
8. Turn-over of Communication Equipment Rooms

3.3 WORK SEQUENCE

A. Coordinate schedule for execution of work performed under this section with Owner, Construction Manager, General Contractor, and other trades.

B. Disruption of Normal Operations

1. Contractor shall identify work that may disrupt Owner's normal operations or otherwise interfere with Owner's use of the premises, and coordinate with Owner, Architect, and other contractors to determine which of the identified project work will disrupt operations or interfere with use of the premises. Owner shall have right of final determination on which identified project work will disrupt operations or interfere with use of the premises. Contractor shall coordinate with Owner to develop and finalize action plans to minimize and mitigate disruption of operations and interference with use of the premises.
   a. Action plans may include scheduling identified work to be executed on days and during hours outside Owner's normal days and hours of operation or on a schedule that minimizes disruption to Owner's normal operations, as defined by the Owner.

2. Contractor shall complete work sequence coordination and obtain approval of action plan and schedule by Owner, Architect, and other contractors prior to the commencement of work on site.
3. Contractor shall include in their bid costs to perform disruptive and interfering work outside standard business days and hours.

3.4 BUILDING ACCESS

A. Arrange for necessary openings in building to allow for admittance of new apparatus.

3.5 DAMAGE

A. Review the site for existing damage, deleterious or unsatisfactory conditions, etc. prior to the commencement of work on site, and report to the Architect/Engineer existing damage, deleterious or unsatisfactory conditions, etc. found, including damage to structure, floors, walls, ceilings, doors, windows, furnishings, equipment, etc.

B. Commencement of work on site indicates Contractor's acceptance of existing conditions. Contractor shall be solely responsible for costs to correct damage or deleterious conditions found in the project area that went unreported prior to the Contractor's commencement of work on site.

C. Contractor shall replace accessible ceiling tiles damaged during the execution of work under this section. Replacement tiles provided shall match manufacturer, part number, size, style, color, texture, etc. of damaged tiles.

3.6 CONTINUITY OF SERVICES

A. No service shall be interrupted, changed, or terminated without written permission from Owner and Architect/Engineer. Obtain written permission prior to commencement of work that may affect services.

B. When work under this section may interrupt services, or when services need to be interrupted as part of execution of work under this section, Contractor shall notify Owner, Architect/Engineer, and other affected parties a minimum of four (4) weeks prior to commencement of work affecting services and coordinate a mutually-agreed-upon schedule for completing that work.

3.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division 01 for additional information and requirements.

B. Transport and handle materials in a manner that avoids damage, preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties.

1. Where applicable, lift only with lugs provided for the purpose.

C. Maintain manufacturer's original material packaging and shipping packaging until material is installed.

D. Store materials in a clean, dry, secure, temperature-controlled location in a manner that preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties. Protect stored material from deleterious substances, agents, conditions, etc. including dust, dirt, debris, moisture, chemicals, chemical compounds, corrosion, temperatures outside material's published tolerance range, etc. and from damage due to intentional or incidental contact, vandalism, neglect, etc.

E. Contractor shall include in their bid costs to deliver, store, and handle materials.

3.8 LOCATIONS OF WORK

A. Field-verify locations, elevations, measurements, etc. prior to installation of materials.

B. Electronic Safety and Security equipment and device locations shown on drawings are diagrammatic and shall not be used for dimensioning of final location. Field-coordinate locations, elevations, measurements, etc. with Owner and with other trades prior to installation of materials.

1. Where architectural features govern location of work and where areas are dense with work of multiple trades, refer to Architectural contract documents. Where work by other trades governs location of work, refer to the contract documents of the other trade. Check, verify, and coordinate work with other trades' contract documents and include modifications, relocations, adjustments, etc. necessary to complete work and prevent interference with other trades.
2. Included in this contract are connections to equipment provided by others. Refer to other trades' contract documents, including Architectural, Electrical, Integrated Automation, Mechanical, and Technology, and to final shop drawings for equipment being furnished under other sections for exact locations of equipment, devices, etc. and of various connections required.

C. Locate equipment, devices, etc. to fit details, panels, decorating, finish, etc. at space. Owner and Architect reserve right to make minor position changes of equipment, device, etc. locations before work has been installed.

D. Contractor shall survey the site and include in their bid costs to perform work as specified in the contract documents.

E. Where conditions on site require adjustments to indicated locations and/or arrangements of equipment, devices, etc., Contractor shall make required changes at no additional cost to the Owner.

3.9 CONCRETE WORK

A. Provide cast-in-place concrete as required by contract documents unless otherwise noted.

B. Concrete shall comply with Division 03 - Concrete.

C. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.

3.10 CUTTING AND PATCHING

A. Refer to General Conditions of Contract and Division 01 for additional information and requirements.

B. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore damaged work to original condition, including openings remaining from removal or relocation of existing system components.

C. Repair damage to walls, floors, ceilings, fixtures, furnishings, etc. caused by installation of work under this section. Repairs must match preexisting condition, color, finish, etc. of walls, floors, ceilings, fixtures, furnishings, etc.

D. Provide materials required for patching and repair, unless otherwise noted.

E. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

F. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

3.11 FLOOR, WALL, ROOF, AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with work by other trades.

B. Size and location of openings, chases, holes, etc. shall be reviewed and approved by Structural Engineer prior to execution.

C. X-ray reinforced concrete floors to identify actual locations of embedded reinforcing elements prior to making openings, chases, holes, etc. and adjust size and location of openings, chases, holes, etc. to avoid embedded reinforcing elements.

D. Openings for penetrations shall be ≥ 1/2” larger on all sides than the outside dimensions of the raceways, and shall have ≥ 50mm(2”) clearance around the openings. Where fire resistant penetrations are required, size openings in accordance with published UL assembly being installed and with firestopping system manufacturer’s published recommendations.

E. Provide sleeves, inserts, etc. that are to be built into structure in a timely manner during progress of construction to prevent delay of work.

F. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

G. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

H. Circular openings, chases, holes, etc. through finished concrete or masonry shall be made by core drilling. Rectangular or square openings, chases, holes, etc. through finished concrete or masonry shall be made by concrete saw. Impact hammer, manual chisel, etc. shall not be used.

I. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

J. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

K. Seal non-rated wall openings with urethane caulk.

L. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

M. Finish and trim penetrations as shown on details and as specified hereinafter.

N. Provide escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

1. Coordinate color and finish of escutcheons with Architect. Escutcheons shall be chrome or nickel plated unless otherwise directed.

O. Wherever installation of this Contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to maintain that integrity. Coordinate these requirements with General Contractor.

P. Wherever installation of this Contractor's equipment destroys sound transmission class (STC) rating integrity of wall, floor, or ceiling, this Contractor shall bear the cost of repair to restore that integrity. Coordinate these requirements with General Contractor.

Q. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

R. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

3.12 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance after completion of project. Contractor shall relocate raceways or accessories as required to provide access at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair, or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Verify room door swings before installing equipment, devices, etc. and install such equipment, device, etc. back boxes on latch side of door unless otherwise noted.

D. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs, or maintenance is located in walls or chases or above inaccessible ceilings.

1. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, minimum sizes, and rough-in dimensions, without limitations.

3.13 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide, or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.14 SUPPORT PROTECTION

A. In occupied areas, electrical rooms, mechanical rooms, utility areas, and areas requiring normal maintenance access, equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft. above floors, platforms, or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.15 INSTALLATION

A. Pre-Installation Inspection

1. Prior to commencement of work on site, Contractor shall inspect the site to evaluate whether site conditions are sufficiently consistent with the Contract Documents to support and facilitate execution of specified work and specified system performance.
2. Contractor shall prepare and submit to the Architect/Engineer and the Owner a report documenting observed inconsistencies that may impact execution of specified work or specified system performance. Report shall include photographs, annotated drawings, written descriptions, etc. to clearly and completely document observed inconsistencies, and itemized recommendations and cost estimates for remediation of each observed inconsistency.
   a. Contractor shall not take any steps to remediate observed inconsistencies without written direction from the Architect/Engineer and the Owner.

3. Commencement of work on site indicates Contractor's confirmation that existing conditions support and facilitate execution of specified work and specified system performance. Contractor shall be solely responsible for costs to remediate inconsistencies that went unreported prior to the Contractor's commencement of work on site.

B. General

1. Refer to manufacturer's product installation instructions, recommendations, and guidelines for additional information and requirements. Wherever a discrepancy is identified between Contract Documents and manufacturer's product installation instructions, the more stringent requirement shall govern.
2. Cable, devices, equipment, etc. shall not be installed until building is enclosed and weather tight, and temperature and humidity conditions are controlled continuously at levels approximately equivalent to final conditions expected after occupancy.
3. Cable, devices, equipment, etc. shall not be installed in areas where installed materials would be exposed to moisture, dust, overspray, or other deleterious conditions.
4. No equipment, devices, cable, etc. shall be installed in Communications Equipment Rooms until room is broom clean and free of debris, dirt, dust, moisture, foreign materials, etc. and room is equipped with operable door that can be closed and latched to prevent ingress of deleterious conditions.
5. Protect installed cable, devices, equipment, etc. from damage through completion of construction and date of Owner's final acceptance.

C. Rough-In

1. Coordinate back box, plaster ring, raceway, surface raceway, cable tray, etc. pathway requirements with Division 26 prior to the commencement of work on site.
2. Where Division 28 equipment or device is provided with an equipment- or device-specific back box, Contractor shall provide that back box to Division 26 prior to commencement of rough-in work on site.
3. Unless noted otherwise, install conduit concealed in walls and ceilings. Conduit in utility spaces and unfinished spaces may be installed exposed.
4. Unless noted otherwise, install pathways and raceways parallel and perpendicular to major building lines.

D. Cable and Conductors

1. Cable shall be listed for installation in the environment in which it is installed.
2. No cable or conductor shall be fished bare through the interior of any enclosed, inaccessible ceiling, wall, or floor structures. Where such installation is required, fish flexible metallic conduit through the structure, secure the flexible metallic conduit at both ends and provide protective bushings at both ends of it, and install cable inside flexible metallic conduit.
3. Install cabling in pathways provided, or as designated on floor plans, and support from building structure.
   a. Where installed in free-air, support cables using J-hook type cable supports. Refer to Section 27 0528.29 - Hangers and Supports for Communications Systems for installation requirements.
      1). J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
      2). Route cable/hooks at right angles, parallel to construction.
   b. Where installed in Cable Tray, lay cables neatly in tray.
      1). Do not tie.

2). Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.

4. Provide pull cord (200 lb minimum) with cable installed in conduit or innerduct.
5. Cable and conductors installed shall be free of defects and damage. Provide required installation tools to facilitate cable and conductor installation without damaging the cable and protect cable and conductors from damage. Visually inspect cable during installation for damage or defects, including cuts, blisters, abrasions, etc. Provide permanent abrasion protection at points where cable or conductors contact surface that could damage the cable or conductors.
6. Pull cable by hand unless installation conditions require mechanical assistance.
7. Do not exceed recommended pulling tensions or bending radii during cable installation.
   a. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.
      1). This may be in form of continuous monitoring of pulling tension, use of "break-away" fitting, or other approved method.
   b. Replace cables bent or kinked to radius less than recommended dimension.
      1). This shall be at no expense to Owner.

8. Pulling lubricant may be used and shall:
   a. Be non-injurious to cable jacket and other materials used.
   b. Not harden or become adhesive with age.

9. Provide an adequate number of workers during cable and conductor pulling operations to observe cable or conductors at points of entry in to and exit from pathways, to feed cable and conductors, and to operate pulling machinery.
10. Cable and conductors shall be installed continuous and splice-free.
11. Installed cable and conductors shall be free of tension.
    a. In cases where cable must bear stress, provide Kellems-type grips to distribute stress over greater length of cable.

12. Maintain manufacturer’s published minimum bend radius on installed cable and conductors. Provide permanent bend radius protection at points where cable and conductors change direction.
13. Unless noted otherwise, install cable and conductors parallel and perpendicular to major building lines.
14. Cable and conductors shall be kept clear of and protected from work by other trades.
15. No cable or conductor shall be attached to or supported in any manner by work by other trades.
16. No cable or conductor shall be laid on accessible ceiling grid or tiles, or attached or supported in any manner by accessible ceiling tiles, grid, or support wires.
17. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.
    a. Strap vertical runs as required to prevent sagging of cables.

18. Route and support cable in Equipment Rooms utilizing horizontal overhead cable runway, wall-mounted vertical cable runway, and wall-mounted "D-type" mounting rings.
19. Neatly lace, dress, and support cabling and conductors.
    a. To reduce effects of EMI, adhere to the minimum cable separation distances defined in TIA-569-C.

E. Termination

1. Install and tighten connectors per manufacturer's instructions, using the appropriate tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, equipment, devices, etc. by over-tightening terminations.
2. Cable and conductor color coding shall be maintained consistent throughout the installation for each equipment and device type.
3. Provide ≥ 12 inches of slack at system equipment and devices, for future retermination.

F. Equipment

1. Unless noted otherwise, install wall mounted equipment in Equipment Rooms between +18" AFF and +72" AFF.

G. Configuration and Programming

1. Coordinate configuration and programming with Owner prior to the commencement of configuration and programming work.
2. Change logins and passwords from manufacturer defaults upon first system startup, prior to the commencement of configuration or programming work. Coordinate logins with Owner prior to the commencement of configuration or programming work. Passwords used during execution of installation, configuration, programming, testing, commissioning, etc. work shall:
   a. Consist of a minimum of eight (8) printable ASCII characters
   b. Include at least one of each of the following:
      1). Capital letters
      2). Lower case letters
      3). Numbers
      4). Special characters

3. Upon system turnover to Owner, change passwords to Owner-defined passwords. Coordinate passwords with Owner prior to system turnover.

3.16 PAINTING

A. Equipment and Devices

1. Unless specified otherwise, furnish equipment with factory applied prime finish.
2. Where factory finish on equipment provided by Contractor is damaged prior to Owner's final acceptance, refinish equipment per manufacturer's instructions and guidelines to satisfaction of Owner and Architect/Engineer.
3. Furnish to Owner one (1) can of manufacturer's touch up paint for each factory finish of Contractor-provided material.

B. Painting of plywood in Equipment Rooms shall be by this Contractor.

3.17 CLEANING AND REPAIR OF EXISTING MATERIALS

A. Where existing materials, devices, equipment, etc. are specified to remain or be reused, clean and repair those existing items before placing back in to service to guarantee like-new operation.

3.18 CABLE AND CONDUCTOR PROTECTION

A. Protect equipment, devices, termination components, cables, conductors, etc. from contact with, and potential application of, foreign materials.

1. For the purposes of this Section, foreign material is defined as material or compound that is not part of equipment, devices, termination components, cable assembly, conductor, etc. when delivered from manufacturer.
   a. Examples include concrete, mortar, drywall compound, primer, paint, stain, polyurethane, varnish, spray foam insulation, and spray-applied fire resistive material.

B. Replace equipment, devices, termination components, cables, conductors, etc. that come into contact with foreign materials, at no cost to project.

C. No solvents, chemicals, compounds, or agents shall be used to remove foreign materials that have accumulated on equipment, devices, termination components, cables, conductors, etc.

3.19 TESTING

A. General

1. Submit with shop drawings documentation of proposed test procedures.
   a. Testing shall not commence without Architect/Engineer's approval of proposed test procedures. Commencement of testing without Archtect/Engineer's approval of proposed test procedures shall be grounds for Architect/Engineer and Owner to reject documentation of related testing and require repeat of related tests at no additional cost to Owner.

2. Prior to testing, visually inspect work to verify completion and compliance with applicable requirements.
3. Coordinate and schedule testing to be complete a minimum of fifteen (15) working days prior to scheduled occupancy, such that the Architect/Engineer and Owner have a minimum of ten (10) working days to review draft test results and the Owner has a minimum of five (5) working days to prepare the phase area for occupancy.
4. Coordinate and schedule testing phases to be complete a minimum of fifteen (15) working days prior to scheduled occupancy of phase area, such that the Architect/Engineer and Owner have a minimum of ten (10) working days to review draft test results and the Owner has a minimum of five (5) working days to prepare the phase area for occupancy.
5. Conduct tests during course of construction when identifiable portion(s) of installation is complete.
   a. Alternatively, testing may be conducted after entire installation is complete, where doing so does not delay project schedule.

6. Coordinate testing of work under this Division connected to or integrated with work under other sections with contractors of other trade(s) involved.
7. Owner and/or Architect/Engineer may, at their option, be in attendance to witness testing. Submit proposed schedule for acceptance testing to Owner and Engineer ≥ ten (10) working days in advance to facilitate their participation.
8. Provide equipment and personnel to conduct acceptance tests.
9. Work shall be 100% fault free, unless otherwise noted. Where systems, equipment, devices, cable, etc. fail to meet required performance on criteria under test, replace or

repair defective work and/or materials at no additional cost to Owner and repeat inspection and test. Replacement materials shall be new.

B. Testing Cable

1. Test installed cable in accordance with applicable standards and cable manufacturer's and equipment manufacturer's published requirements, guidelines, and best practices.
2. At a minimum, testing of installed cable shall include:
   a. Test for opens on each conductor
   b. Test for conductor-to conductor shorts, among all conductors
   c. Test for conductor to ground shorts, for each conductor (where applicable)
   d. Test for compliance with applicable cable performance standards (e.g., Category 3, Category 5e, Category 6, Category 6A, OS2, OM3, OM4, etc.)
      1). Refer to Section 27 1000 for additional information on and requirements for testing structured cabling.
   e. Tests recommended by manufacturer of associated equipment or devices.

C. Testing Devices

1. Verify proper operation of each feature and function of each device.
2. Verify that each device has been configured and programmed in accordance with requirements of the project documents and Owner's direction.

D. Test Documentation

1. Document and certify, in writing, test results.
2. Maintain copies of certified test results, including those for failed tests, at project site through completion of project.

E. Re-Testing

1. Architect/Engineer or Owner may, at their option, request that a random 10% re-test be conducted by this Contractor at no additional cost to Owner to verify documented findings. Re-testing conducted shall be an exact repeat of those conducted and documented previously.
2. Owner may, at their option, also perform independent re-testing to verify documented findings.
3. If re-test findings contradict previous test documentation submitted by Contractor, additional re-testing shall be performed by this Contractor at no additional cost to Owner. The extent of such additional re-testing, including a 100% re-test, shall be determined solely by the Architect/Engineer and Owner.

3.20 START-UP

A. Systems and equipment shall be started, adjusted, tested, etc. and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Where specified, provide at no additional cost to Owner the services of manufacturer's personnel for start-up, adjustment, and checkout of systems and equipment provided.

C. Provide the services of a manufacturer-trained and -certified technician who is knowledgeable in the start-up, adjustment, and checkout of the types of systems and equipment provided and is experienced with the specific materials provided.

1. Where Contractor does not employ such a technician directly on their own staff, Contractor shall provide at no additional cost to Owner such services from manufacturer's personnel.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Follow manufacturer's pre-start-up checkout, start-up, adjustment, and troubleshooting procedures.

F. Coordinate start-up with Owner and other trades.

3.21 DOCUMENTATION

A. Refer to Division 01 for additional information and requirements.

B. Refer to 280000 - 1.10 - Submittals for additional information and requirements.

C. Refer to technical sections for additional information and requirements.

D. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

1. Operation and Maintenance Documents
2. Record Drawings

E. Submit final versions of System Documentation within thirty (30) calendar days of completion of last testing phase (e.g., building, area, floor, section, subsystem, cable type, etc.).

3.22 CLEANING

A. Refer to Division 01 for additional information and requirements.

B. Refer to individual technical sections for additional information and requirements specific to work under that section.

C. Contractor shall, periodically, throughout execution of work under this section and/or as directed by Architect/Engineer, Owner, Construction Manager, or General Contractor, remove waste materials, trash, rubbish, debris, etc. generated by execution of work under this section from building and leave work areas broom clean.

1. Construction waste shall be managed in accordance with provisions of Section 01524 Construction Waste Management.

D. After installation is complete and prior to Owner's final acceptance, Contractor shall clean work provided under this section.

1. Remove unused materials, tools, installation equipment, etc. from the site.

2. Faceplates, devices, components, equipment, enclosures, junction boxes, pull boxes, etc. shall be clean and free of stains, dust, dirt, debris, oil, grease, paint, and any other foreign material.
3. The interiors of equipment enclosures, junction boxes, pull boxes, etc. shall be clean and free of wire/cable scraps, pieces of wire/cable insulation, stains, dust, dirt, debris, oil, grease, paint, and any other foreign material.
4. Remove temporary labels not used for instruction or operation.
5. Walls and floors of Electronic Safety and Security spaces and equipment rooms shall be clean and free of dust, dirt, debris, oil, grease, paint, and any other foreign material.
6. Remove and properly dispose of waste materials, trash, rubbish, debris, etc. generated by execution of work under this section.
7. Contractor's cleaning protocol shall not damage provided materials in any way, or invalidate the manufacturer's warranty on provided materials.
    a. Contractor's cleaning protocol shall only include methods and use of solvents, chemicals, compounds, and agents approved by the material manufacturer for use on their product.

3.23 TRAINING

A. Refer to Division 01 for additional information and requirements.

B. Refer to 280000 - 1.10 - Submittals for additional information and requirements.

C. Refer to technical sections for additional information and requirements specific to work under each section.

D. Contractor shall train the Owner's designated representative(s) on the systems provided as part of the work under this Division. Training shall include:

1. System topology
2. Equipment, devices, cable, etc. that constitute the installed system
3. Equipment Room layouts
4. Location of equipment, devices, etc.
5. Labeling scheme logic and label formats
6. Core operating principles ("how it works")
7. Features and functionality
8. Startup process
9. Operation
10. Execution of tasks
11. Commands
12. Shut down process
13. Restart and recovery process
14. Care and maintenance, to include:
    a. Recommended tasks
    b. Recommended schedule / intervals for each task
    c. Step-by-step instructions for execution of each task
    d. Items required to perform each task, to include:
        1). Tools
        2). Parts
        3). Consumable materials (cleaners, lubricants, etc.)

15. Troubleshooting, fault diagnosis, and remediation, to include:

a. Common issues and malfunctions
b. Methods and execution of troubleshooting and fault diagnosis
c. Step-by-step instructions for execution of remediation:
d. Items required to perform remediation, to include:
   1). Tools
   2). Parts
   3). Consumable materials (cleaners, lubricants, etc.)

16. Contents of Operation and Maintenance Documents and Record Drawings

E. Provide comprehensive manuals prepared to provide a written version of specified instruction, and use these written manuals as reference materials during in-person verbal training sessions. Provide the manuals in .pdf electronic form, and provide one (1) printed, bound copy of the manuals for each Owner's designated representative attending in-person verbal training sessions, in addition to quantity specified to be provided as part of Operation and Maintenance Documents.

F. In-person verbal training sessions shall include a walking tour component to observe the actual work in the facility and a "classroom" component based on the written manuals.

G. Coordinate training schedules with Owner and Architect/Engineer. No training session shall be scheduled with less than ten (10) business days' advance notification for attendees.

H. Attendees shall include Owner's designated representatives.

I. Training shall be held at Project Site and shall be conducted on Owner's standard days of operation during Owner's standard working hours.

J. Owner may, at their option, videotape training session(s) for use as future refresher materials for Owner's staff.

K. Refer to technical sections for minimum duration of in-person verbal training sessions specific to work under each section.

END OF SECTION 280000

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Note:

The following is provided as an aid in understanding overall submittal requirements for Division 28 sections. Some sections and/or items may not apply. Contractor is responsible for submitting product data for all pertinent items specified in Division 28 Technical Sections include in project.

28 0000 - General Communications Requirements

None Required

28 1300 - Electronic Access Control

Refer to 28 0000 - 1.10

Refer to 28 0000 - 1.11

Intelligent System Controller

Credential Reader Interface Module

Input Control Module

Output Control Module

Credential Reader

Cable

Raceways and Boxes

28 2300 - Video Surveillance

Refer to 28 0000 - 1.10

Refer to 28 0000 - 1.11

Fixed Video Surveillance Cameras

PTZ Video Surveillance Cameras

Cable

Raceways and Boxes

***

END

SECTION 281000 - ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Electronic Access Control. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

1.2 DESCRIPTION

A. Refer to Section 280000 for additional information and requirements.

B. Complete, turnkey Electronic Access Control system compliant with applicable codes and standards referenced herein and as indicated on drawings.

C. The Electronic Access Control system shall include the following major components:

1. Electronic Access Control System Application Software
2. Intelligent System Controllers
3. Credential Reader Interface Modules
4. Input Control Modules
5. Output Control Modules
6. Electronic Access Control Panel Enclosure
7. Electronic Access Control Power Supply
8. Credential Readers
9. Credentials
10. Electrified Door Locking Hardware
11. Latch Bolt Monitors
12. Door Position Monitors
13. Request to Exit Devices
14. Duress/Panic Button Control Panel
15. Duress/Panic Button
16. Electronic Access Control Cable
17. Electronic Access Control Raceways and Boxes
18. Electronic Access Control Surface Raceways

1.3 RELATED WORK

A. Refer to Section 280000 for additional information and requirements.

B. Related Division 28 Sections include:

1. Section 280000 - General Electronic Safety and Security Requirements
2. Section 28 2000 - Video Surveillance

1.4 REFERENCES AND STANDARDS

A. Refer to Section 280000 for additional information and requirements.

1.5 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 280000 for additional information and requirements.

1.6 DEFINITIONS

A. Refer to Section 280000 for additional information and requirements.

1.7 WORK BY OWNER

A. Refer to Section 280000 for additional information.

B. Owner will provide:

1. Existing Electronic Access Control system server and software
2. Electronic Access Control credentials

1.8 QUALITY ASSURANCE

A. Refer to Section 280000 for additional information and requirements.

1.9 SUBMITTALS

A. Shop Drawings:

1. Refer to Section 280000 for additional information and requirements.

B. Certificates and Inspections

1. Refer to Section 280000 for additional information and requirements.

C. Operation and Maintenance Manuals

1. Refer to Section 280000 for additional information and requirements.

D. Record Drawings

1. Refer to Section 280000 for additional information and requirements.

1.10 WARRANTY

A. Refer to Section 280000 for additional information and requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Section 280000 for additional information and requirements.

B. Unless noted otherwise, the following equipment and devices shall be the products of a single manufacturer and designed, manufactured, marketed, sold, and supported as an integrated system:

1. Electronic Access Control System Application Software
2. Intelligent System Controllers
3. Credential Reader Interface Modules
4. Input Control Modules
5. Output Control Modules
6. Electronic Access Control Panel Enclosure
7. Electronic Access Control Power Supply

2.2 PRODUCT SUBSTITUTIONS

A. Refer to Section 280000 for additional information and requirements.

2.3 ELECTRONIC ACCESS CONTROL SYSTEM APPLICATION SOFTWARE

A. Manufacturer: LenelS2

B. Provide new device licenses required to support new system devices provided as part of this project to provide Electronic Access Control functionality specified on project documents.

2.4 INTELLIGENT SYSTEM CONTROLLERS

A. Features:

1. Compatible with LenelS2 NetBox system software
2. Supports up to 32 credential readers, 160 input points, and 144 output points
3. Supports Wiegand credential reader communication
4. Supports proximity and SMART credential technology
5. Onboard configuration backup
6. Nonvolatile memory for operating system, configuration data, and operations data storage and backup
7. Programmable via Ethernet or RS-232
8. UL listed

B. Specifications:

1. Host Communications: Ethernet via RJ-45 connector
2. Accessory Module Communications: RS-485 via terminal strip connector
3. Input Power Requirements: 1 amp at 12 volts DC
4. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. LenelS2 NetBox

D. Acceptable Alternates:

1. None.

2.5 CREDENTIAL READER INTERFACE MODULES

A. Features:

1. Supports two electronic access control doors, each with:
   a. One credential reader
      1). Includes connections for reader power, reader data, red lamp, green lamp
   b. Two supervised inputs
   c. Two outputs

2. Supports Wiegand credential reader communication
3. Supports proximity and SMART credential technology
4. UL listed

B. Specifications:

1. Controller Communications: RS-485 via terminal strip connector
2. Input Power Requirements: 2 amps at 12 volts DC
3. Reader Power Output: ≤ 250 milliamps at 12 volts DC
4. Reader LED Power Output: ≤ 100 milliamps at 12 volts DC
5. Relay Output Rating: ≤ 1 amp at 12-24 volts DC
6. Connections: Terminal strip
7. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. LenelS2 Access Control Application Blade

D. Acceptable Alternates:

1. None.

2.6 INPUT CONTROL MODULES

A. Features:

1. Supports eight Class A supervised inputs
2. UL listed

B. Specifications:

1. Controller Communications: RS-485 via terminal strip connector
2. Input Power Requirements: 180 milliamps at 12 volts DC
3. Connections: Terminal strip

4. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. LenelS2 Supervised Input Application Blade

D. Acceptable Alternates:

1. None.

2.7 OUTPUT CONTROL MODULES

A. Features:

1. Supports eight Form C dry contact relay outputs
2. UL listed

B. Specifications:

1. Controller Communications: RS-485 via terminal strip connector
2. Input Power Requirements: 300 milliamps at 12 volts DC
3. Relay Output Rating: ≤ 2 amps at 30 volts DC resistive, ≤ 1 amps at 30 volts DC inductive, ≤ 400 milliamps at 125 volts AC
4. Connections: Terminal strip
5. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. LenelS2 Relayed Output Application Blade

D. Acceptable Alternates:

1. None.

2.8 ELECTRONIC ACCESS CONTROL PANEL ENCLOSURE

A. Features:

1. Wall mount
2. NEMA Type 1 steel enclosure with powder coat finish and lockable hinged door
3. Integral power supply with battery charging capability
4. Integral mounting brackets for housing backup batteries
5. Door tamper switch
6. UL listed

B. Specifications:

1. Dimensions: ≥ 16”w x 24”h x 4”d
2. Power Supply Input: 0.5 amps at 120 volts AC
3. Operating Temperature (Environmental): 32°F - 122°F

C. Basis of Design:

1. LenelS2

D. Acceptable Alternates:

1. None.

E. Provide complete with:

1. Quantity of 7AH sealed lead acid or gel type batteries sufficient to provide a minimum of one (1) hour of battery backup run time.
2. Minimum 1”x1” slotted finger duct as required for internal routing of cabling from where it enters the panel enclosure to termination points on system components and modules.
   a. Provide in larger dimensions as required to maintain maximum 40% fill.
      1). Fill calculation shall be based on anticipated amount of cable in a fully-populated panel enclosure.

3. Minimum 3”x3” slotted finger duct around perimeter of each panel enclosure, with section of same duct product extended from perimeter of each panel enclosure to horizontal ladder rack above panel enclosure.
   a. Provide in larger dimensions as required to maintain maximum 40% fill.
      1). Fill calculation shall be based on anticipated amount of cable associated with typical fully-populated panel enclosures.

2.9 ELECTRONIC ACCESS CONTROL POWER SUPPLY

A. Features:

1. Wall mount
2. Steel enclosure with powder coat finish
3. Battery charging capability
4. Integral mounting brackets for housing backup batteries
5. Eight outputs
   a. 12 volt DC
   b. Fused
   c. Independently controlled
   d. Fail safe or fail secure
   e. Activated by open collector sink or normally open dry contact

6. Fire alarm disconnect input
   a. Normally open or normally closed
   b. Latching or non-latching
   c. Individually selectable for each output

7. AC input fail supervision contact
8. Battery presence and low battery supervision contact
9. LED indicators for AC input, DC output, individual output status, and fire alarm disconnect status
10. UL listed

B. Specifications:

1. Dimensions: 12”w x 15.5”h x 4.5”d
2. Power Supply Input: 3.5 amps at 120 volts AC

3. Power Supply Output: 10 amps at 12 volts DC
4. Operating Temperature (Environmental): 32°F - 120°F

C. Basis of Design:

1. Altronix AL1012ULACM

D. Acceptable Alternates:

1. None.

E. Provide complete with:

1. Internally-mounted door tamper switch accessory
2. Quantity of 12AH sealed lead acid or gel type batteries sufficient to provide a minimum of one (1) hour of battery backup run time.
3. Minimum 3”x3” slotted finger duct around perimeter of each power supply enclosure, with section of same duct product extended from perimeter of each enclosure to horizontal ladder rack above enclosure.
   a. Provide in larger dimensions as required to maintain maximum 40% fill.
      1). Fill calculation shall be based on anticipated amount of cable associated with typical fully-populated panel enclosures.

F. Provide in quantity to maintain a maximum of 60% utilization of power supply output capacity.

2.10 CREDENTIAL READERS

A. Wall Mounted Medium-Range Keypad Credential Readers

1. Features:
   a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
   b. Mounts to a standard single gang electrical opening
   c. Supports SMART and proximity credential technologies
   d. Integral keypad
   e. Integral bi-color LED indicator
   f. Integral sounder
   g. Integral tamper switch
   h. UL listed

2. Specifications:
   a. Dimensions: 3.3”w x 4.8”h x 1.1” deep
   b. Operating Frequency: 13.56 MHz, 125 kHz
   c. Read Range: 1.6 - 4.7”, credential dependent
   d. Output Communication Protocol: Wiegand or Clock-and-Data
   e. Input Voltage: 12 volts DC
   f. Power Consumption, Average: 95 milliamps at 12 volts DC
   g. Power Consumption, Peak: 200 milliamps at 12 volts DC
   h. Connections: Terminal strip
   i. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:
   a. HID RP40

4. Acceptable Alternates:
   a. None.

B. Mullion Mounted Medium-Range Credential Readers

1. Features:
   a. IP-55 rated weather-resistant and vandal-resistant grey polycarbonate housing
   b. Supports SMART and proximity credential technologies
   c. Integral bi-color LED indicator
   d. Integral sounder
   e. Integral tamper switch
   f. UL listed

2. Specifications:
   a. Dimensions: 1.9”w x 4.1”h x 0.9” deep
   b. Operating Frequency: 13.56 MHz, 125 kHz
   c. Read Range: 1.6 - 3.1”, credential dependent
   d. Output Communication Protocol: Wiegand or Clock-and-Data
   e. Input Voltage: 12 volts DC
   f. Power Consumption, Average: 75 milliamps at 12 volts DC
   g. Power Consumption, Peak: 200 milliamps at 12 volts DC
   h. Connections: Terminal strip
   i. Operating Temperature (Environmental): -31°F - 150°F

3. Basis of Design:
   a. HID RP10

4. Acceptable Alternates:
   a. None.

2.11 CREDENTIALS

A. Credentials provided by Owner.

2.12 ELECTRIFIED DOOR LOCKING HARDWARE

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 08.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.13 LATCH BOLT MONITORS

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 08.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.14 ELECTRONIC LOCKETS

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 28.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.15 MAGNETIC LOCKS

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 08.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

2.16 ELECTRIC STRIKES

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 08.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

~~C.~~

~~2.14~~2.17 DOOR POSITION MONITORS

A. Specified by Division 08.

1. Refer to Division 08 for additional information and requirements.

B. Furnished and installed by Division 08.

1. Refer to Division 08 for additional information and requirements.

C. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

~~2.15~~2.18 REQUEST TO EXIT DEVICES

A. Request to Exit Switch integral to Electrified Door Locking Hardware

1. Specified by Division 08.
   a. Refer to Division 08 for additional information and requirements.

2. Furnished and installed by Division 08.
   a. Refer to Division 08 for additional information and requirements.

3. Cabled, terminated, configured, programmed, tested, adjusted and made completely ready for use by This Contractor.

B. Motion-Sensing Request to Exit Devices

1. Features:
   a. Black ABS plastic housing
   b. Wall or ceiling mountable
   c. Adjustable pitch
   d. Adjustable coverage pattern
   e. Adjustable relay latch time
   f. Integral activation LED
   g. UL listed

2. Specifications:
   a. Alarm Output: Form C relay contacts rated at 1 amp at 30 volts DC
   b. Power Consumption, Average: 8 milliamps at 12 volts DC
   c. Power Consumption, Peak: 39 milliamps at 12 volts DC
   d. Operating Temperature (Environmental): -20°F - 120°F

3. Basis of Design:
   a. Bosch DS161

4. Acceptable Alternates:
   a. None.

5. Provide complete with same manufacturer's matching trim plate accessory for mounting over a single gang electrical opening.

C. Push-Button Request to Exit Devices with Pneumatic Timer

1. Features:
   a. Single gang stainless steel faceplate
   b. Wall mountable
   c. Red mushroom button
      1). Engraved with “PUSH TO EXIT” in white text
   d. Integral field-adjustable pneumatic time delay
   e. UL listed

2. Specifications:
   a. Alarm Output: Form C relay contacts rated ≥ 2 amps at 28 volts DC
   b. Time Delay Range: ≥ 2 - 45 seconds

3. Basis of Design:
   a. Alarm Controls TS-60

4. Acceptable Alternates:
   a. Camden
   b. Rutherford

~~2.16~~2.19 ELECTRONIC ACCESS CONTROL CABLE

A. General

1. Refer to manufacturer’s published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer’s published product installation instructions, the more stringent requirement shall govern.
2. Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed.
   a. Refer to Mechanical drawings for additional information and requirements.

3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

B. Intelligent System Controller Cable

1. Ethernet Cable
   a. 4-pair UTP
      1). Refer to Section 27 1500 for information and requirements.
      2). Ethernet cable patch panel by Division 27. Refer to Section 271500 for additional information.

2. Ethernet Patch Cables
   a. 4-pair UTP
      1). Refer to Section 271600 for information and requirements.

3. RS-485 Cable
   a. 18/3 shielded
   b. Low-capacitance
   c. Basis of Design:
      1). Plenum: Belden 88770
      2). Nonplenum: Belden 8770
   d. Acceptable Alternates:

1). West Penn

C. Credential Reader Cable

1. 18/6 shielded
2. Basis of Design:
   a. Plenum: Belden 6304FE
   b. Nonplenum: Belden 5304FE

3. Acceptable Alternates:
   a. West Penn

D. Electrified Door Locking Hardware Cable

1. Minimum 14/2 unshielded
   a. Provide in gauge(s) as required to maintain no more than 10% voltage drop

2. Basis of Design:
   a. Plenum: Belden 6100UE
   b. Nonplenum: Belden 5100UE

3. Acceptable Alternates:
   a. West Penn

E. Latch Bolt Monitor Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

F. Door Position Monitor Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

G. Request to Exit Device Cable

1. Request to Exit Switch integral to Electrified Door Locking Hardware
   a. 18/2 unshielded
   b. Basis of Design:
      1). Plenum: Belden 6300UE
      2). Nonplenum: Belden 5300UE
   c. Acceptable Alternates:
      1). West Penn

2. Motion-Sensing Request to Exit Devices
   a. 18/4 unshielded
   b. Basis of Design:
      1). Plenum: Belden 6302UE
      2). Nonplenum: Belden 5302UE
   c. Acceptable Alternates:
      1). West Penn

H. Local Alarm Sounder Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

I. Local Alarm Strobe Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

J. Local Alarm Sounder/Strobe Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

K. Automatic Door Operator Integration Cable

1. 18/2 unshielded
2. Basis of Design:
   a. Plenum: Belden 6300UE
   b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
   a. West Penn

L. Automatic Door Operator Actuator Integration Cable

1. Push Button Automatic Door Operator Actuator
   a. 18/2 unshielded
   b. Basis of Design:
      1). Plenum: Belden 6300UE

2). Nonplenum: Belden 5300UE
c. Acceptable Alternates:
1). West Penn

2. Contactless “Hands-Free” Automatic Door Operator Actuator
a. 18/4 unshielded
1). Basis of Design
a). Plenum: Belden 6302UE
b). Nonplenum: Belden 5302UE
b. Acceptable Alternates:
1). West Penn

M. System Equipment Panel Door Tamper Monitor Cable

1. 18/2 unshielded
2. Basis of Design:
a. Plenum: Belden 6300UE
b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
a. West Penn

N. Knox-Style Key Vault Door Tamper Monitor Cable

1. 18/2 unshielded
2. Basis of Design:
a. Plenum: Belden 6300UE
b. Nonplenum: Belden 5300UE

3. Acceptable Alternates:
a. West Penn

~~2.17~~2.20 ELECTRONIC ACCESS CONTROL RACEWAYS AND BOXES

A. Refer to Section 260533 for additional information and requirements.

B. Conduit

1. Wall Mounted Devices:
a. Minimum 3/4" trade size.

2. Door Frame Mounted Devices:
a. Minimum 1/2" trade size.

3. No flexible conduit of any type.

C. Device Back Boxes

1. Wall Mounted Devices:
a. Dimensions: Minimum 4” square, 2-1/8” deep

2. Door Frame Mounted Devices

a. Dimensions: Minimum 4” x 2”, 1-1/4” deep

~~2.18~~2.21 ELECTRONIC ACCESS CONTROL SURFACE RACEWAYS

A. Refer to 260533 for additional information and requirements.

B. Minimum capacity equivalent to 3/4" trade size conduit.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION COORDINATION MEETING

A. Prior to preparation and submission of shop drawings, Contractor shall arrange and conduct a pre-construction coordination meeting to review and coordinate aspects of the Electronic Access Control installation.

1. At a minimum, attendees shall include:
   a. Owner’s project manager, security representative, and facilities / buildings and grounds / maintenance door representative
   b. Construction Manager / General Contractor project manager and site superintendent / field foreman
   c. Division 08 subcontractor site superintendent / field foreman
   d. Door frame, leaf, and hardware supplier representative(s)
   e. Door hardware manufacturer’s representative
   f. Division 26 subcontractor site superintendent / field foreman
   g. Division 28 project manager and site superintendent / field foreman
   h. Electronic access control subcontractor/supplier representative

2. At a minimum, meeting agenda topics shall include:
   a. Review and coordination of division of work among trades.
   b. Identification and review of each door to be equipped with electronic access control devices, to include:
      1). Location
      2). Intended functionality and operation
      3). Door hardware complement
      4). Electronic access control device complement
      5). Electronic access control device and cable rough-in requirements
   c. Review of construction schedule and coordination of inter-trade installation schedule interdependencies
   d. Coordination of door frame and door leaf mounted electronic access control device installation and wiring
   e. Coordination of device configuration, testing, and adjustment

3. Meeting shall be scheduled with a minimum of two weeks’ notice.
   a. Contractor shall publish a meeting agenda for the meeting and distribute to invited attendees a minimum of one week prior to the meeting.

4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.2 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

A. After Section 281000 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate aspects of Electronic Access Control device and equipment configuration and programming.

1. At a minimum, attendees shall include:
   a. Owner's project manager, security representative, and facilities / buildings and grounds / maintenance door representative
   b. Division 28 project manager and site superintendent / field foreman
   c. Electronic access control subcontractor/supplier project manager and system programmer

2. At a minimum, meeting agenda topics shall include:
   a. Identification and review of each door to be equipped with electronic access control devices, to include:
      1). Location
      2). Intended functionality and operation
      3). Door hardware complement
      4). Electronic access control device complement
      5). Configuration of and programming for each device
   b. Identification and review of electronic access control devices not associated with a door, to include:
      1). Location
      2). Intended functionality and operation
      3). Configuration of and programming for each device
   c. Review of a product-specific configuration and programming guide detailing configuration and programming options applicable to the system software, hardware, equipment, and devices being provided.
   d. Configuration of credential holder database and programming of individual credential holders
   e. Configuration and programming of system server(s) and workstations and of server/workstation graphical user interface screens
   f. Review of installation, configuration, programming, and testing schedule, and of how those relate to the overall construction schedule.

3. Meeting shall be held a minimum of two weeks prior to the commencement of configuration and programming work, and shall be scheduled with a minimum of two weeks' notice.
   a. Contractor shall publish a meeting agenda for the meeting and distribute the meeting agenda and configuration and programming guide to invited attendees a minimum of one week prior to the meeting.

4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.3 GENERAL

A. Refer to Section 280000 for additional information and requirements.

3.4 OWNER INSPECTION

A. Refer to Section 280000 for additional information and requirements.

3.5 WORK SEQUENCE

A. Refer to Section 280000 for additional information and requirements.

3.6 TEMPORARY SERVICES

A. Refer to Section 280000 for additional information and requirements.

3.7 BUILDING ACCESS

A. Refer to Section 280000 for additional information and requirements.

3.8 DAMAGE

A. Refer to Section 280000 for additional information and requirements.

3.9 DEMOLITION

A. Refer to Section 280000 for additional information and requirements.

3.10 CONTINUITY OF SERVICES

A. Refer to Section 280000 for additional information and requirements.

3.11 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 280000 for additional information and requirements.

3.12 LOCATIONS OF WORK

A. Refer to Section 280000 for additional information and requirements.

3.13 CONCRETE WORK

A. Refer to Section 280000 for additional information and requirements.

3.14 CUTTING AND PATCHING

A. Refer to Section 280000 for additional information and requirements.

3.15 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Refer to Section 280000 for additional information and requirements.

3.16 EQUIPMENT ACCESS

A. Refer to Section 280000 for additional information and requirements.

3.17 EQUIPMENT SUPPORTS

A. Refer to Section 280000 for additional information and requirements.

3.18 SUPPORT PROTECTION

A. Refer to Section 280000 for additional information and requirements.

3.19 INSTALLATION

A. Refer to Section 28 0000 for additional information and requirements.

B. General

1. Integrate new work under this project in to Owner's existing system.

C. System Servers and Application Software

1. Coordinate exact location with Owner and work by other trades prior to installation.
2. Coordinate schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
3. Properly ground system servers with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 270526 for additional information and requirements.
4. Provide surge protective device in-line just before connection to electrical receptacle.
5. Provide surge protective device in-line just before connection to Ethernet jack.
6. Coordinate configuration of server operating system software with Owner and with system application software manufacturer prior to installation and configuration.
7. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

D. System Workstations and Application Software

1. Coordinate exact location with Owner and work by other trades prior to rough-in.
2. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
3. Provide surge protective device in-line just before connection to electrical receptacle.
4. Provide surge protective device in-line just before connection to Ethernet jack.
5. Coordinate configuration of workstation operating system software with Owner and with system application software manufacturer prior to installation and configuration.
6. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

E. Intelligent System Controllers, Credential Reader Interface Modules, Input Control Modules, and Output Control Modules

1. Install intelligent system controllers and input/output control modules centralized in manufacturer's matching wall-mounted control panel enclosures in the nearest Equipment Room. Coordinate exact location(s) with Owner and work by other trades prior to installation.
   a. Electronic access control panel enclosure power supplies shall be fed via minimum 20-amp emergency power electrical circuit, dedicated to electronic access control system head end equipment.
      1). Provide machine-generated label on interior of the panel enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
      2). Provide hard-wired surge protective device in-line just before connection to the power supply.
   b. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
   c. Properly ground system control panel cabinets and system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 27 0526 for additional information and requirements.

2. Cable shields and drain conductors of system communications cabling linking controllers in multiple locations shall be bonded to ground at primary system equipment location only.
3. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

F. Electronic Access Control Power Supplies

1. Install electronic access control power supplies wall-mounted immediately adjacent to associated electronic access control panel enclosures. Coordinate exact location(s) with Owner and work by other trades before installation.
2. Electronic access control power supplies shall be fed via minimum 20-amp critical power electrical circuit, dedicated to electronic access control system head end equipment.
   a. Provide machine-generated label on interior of the power supply enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
   b. Provide hard-wired surge protective device in-line just before connection to the power supply.

3. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
4. Properly ground electronic access control power supplies with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 270526 for additional information and requirements.
5. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

G. Credential Readers

1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.

2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
3. Install in accordance with the Americans with Disabilities Act and the Americans with Disabilities Act Accessibility Guidelines.
4. Where readers are specified to be installed on both sides of a wall, maintain sufficient physical separation between them to prevent cross-reading of credentials through the wall.
5. Mount exterior credential readers with stainless steel fasteners.
6. Provide surge suppression for exterior credential readers mounted on a column, pedestal, etc., not directly on the exterior wall of the building or directly on the exterior side of a door mullion.
7. Cable shields and drain conductors of credential reader cabling shall be bonded to ground at credential reader interface module location only.
8. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

H. Electrified Door Locking Hardware

1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.

I. Latch Bolt Monitors

1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.

J. Door Position Monitors

1. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
2. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
3. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.

K. Request to Exit Devices

1. Request to Exit Switch integral to Electrified Door Locking Hardware
   a. Coordinate rough-in requirements with Division 08 Contractor and Division 26 Contractor prior to the commencement of work on site.
   b. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
   c. Coordinate cabling, termination, testing, and adjustment with on-site Division 08 Contractor.

2. Motion-Sensing Request to Exit Devices
   a. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
   b. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.

c. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
d. Mask sensor lens, aim, tune, and adjust as necessary to minimize false activation from persons passing by but not exiting through the portal while still maintaining necessary REXing functionality.

L. Local Alarm Sounders, Strobes, and Sounder/Strobes

1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
3. Mount exterior local alarm sounders, strobes, and sounder/strobes with stainless steel fasteners.
4. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

M. System Equipment Panel Door Tamper Monitors

N. Duress/Panic Button Control Panels

1. Install duress/panic button control panels centralized in the nearest Equipment Room. Coordinate exact location(s) with Owner and work by other trades before installation.
   a. Duress/panic button control panels shall be fed via minimum 20-amp critical power electrical circuit, dedicated to electronic access control system head end equipment.
      1). Provide machine-generated label on interior of the panel enclosure door indicating the name and number of the room where the electrical distribution panel the circuit originates in is located, the name/number of the distribution panel, and the number of the circuit.
   b. Coordinate power requirements, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to the commencement of work on site.
   c. Properly ground system control panel cabinets and system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs. Refer to Section 27 0526 for additional information and requirements.

2. Coordinate provision of analog phone lines with Owner. Cross-connect Owner-provided analog phone lines to Duress/Panic Button Control Panel and configure dial-out functionality with Owner's remote monitoring service provider.
3. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
   a. Integrate with Intelligent System Controllers and Input Control Modules to provide annunciation of duress/panic button activation through Electronic Access Control system software user interface.

O. Duress/Panic Buttons

1. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
2. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
3. Install in accordance with the Americans with Disabilities Act and the Americans with Disabilities Act Accessibility Guidelines.
4. Coordinate installation and routing of device cable from 4" square x 2-1/8" deep back box at nearest wall to actual device location with Owner and casework or modular furniture

prior to rough-in. Provide back box with single gang plaster ring, minimum 3/4" EMT conduit to cable tray above nearest accessible ceiling, and faceplate that supports method of routing cable from box to device.

5. Cable, terminate, configure, program, test, adjust, and make completely ready for use.

P. Automatic Door Operator and Automatic Door Operator Actuator Integration

Q. Knox-Style Key Vault Door Tamper Monitor Integration

R. Automated External Defibrillator (AED) Tamper Monitor Integration

S. Electronic Access Control Cable

1. Electronic Access Control System cabling shall be installed in conduit from device location to cable tray below nearest accessible floor or above nearest accessible ceiling.
2. Identification:
   a. Label system device cabling with unique alphanumeric identifiers that include:
      1). Architectural door number
      2). Associated system device
      3). Unique alphanumeric identifier to distinguish between multiple instances of same device type at a door, where applicable
   b. Refer to Section 27 0553 for additional information and requirements.

T. Electronic Access Control Raceways and Boxes

1. Refer to Section 280000 for additional information and requirements.

U. Electronic Access Control Surface Raceways

1. Refer to 280000 for additional information and requirements.

V. Configuration and Programming

1. Coordinate configuration and programming with Owner.
2. Coordinate IP address requirements with Owner a minimum of six weeks prior to commencement of programming work.
3. Integration with other systems

3.20 PAINTING

A. Refer to Section 280000 for additional information and requirements.

3.21 CLEANING AND REPAIR OF EXISTING MATERIALS

A. Refer to Section 280000 for additional information and requirements.

3.22 UTILITY SERVICES

A. Refer to Section 280000 for additional information and requirements.

3.23 CABLE AND CONDUCTOR PROTECTION

A. Refer to Section 280000 for additional information and requirements.

3.24 TESTING

A. Refer to Section 280000 for additional information and requirements.

3.25 START-UP

A. Refer to Section 280000 for additional information and requirements.

3.26 DOCUMENTATION

A. Refer to Section 280000 for additional information and requirements.

3.27 CLEANING

A. Refer to Section 280000 for additional information and requirements.

3.28 TRAINING

A. Refer to Section 280000 for additional information and requirements.

B. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 1-hour-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 281000

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SECTION 282000 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Video Surveillance.

1.2 DESCRIPTION

A. Refer to Section 28 0000 for additional information and requirements.

B. Complete, turnkey video surveillance system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

C. The video surveillance system shall include, but not be limited to, the following major components:

1. Video Surveillance System Application Software
2. Ethernet Networking Equipment
3. Video Surveillance Cameras
4. Media Converters
5. Video Encoders
6. Video Decoders
7. Video Monitors
8. Video Surveillance Cable
9. Uninterruptible Power Supplies

1.3 RELATED WORK

A. Refer to Section 28 0000 for additional information and requirements.

B. Related Division 28 Sections include:

1. Section 28 0000 - General Electronic Safety and Security Requirements
2. Section 28 1000 - Electronic Access Control

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Refer to Section 28 0000 for additional information and requirements.

1.5 REFERENCES AND STANDARDS

A. Refer to Section 28 0000 for additional information and requirements.

1.6 DEFINITIONS

A. Refer to Section 28 0000 for additional information and requirements.

1.7 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 28 0000 for additional information and requirements.

1.8 WORK BY OWNER

A. Refer to Section 28 0000 for additional information.

B. Owner will provide:

1. Existing Video Surveillance system server and software
2. Video Surveillance system storage, for retention of recorded video

1.9 QUALITY ASSURANCE

A. Refer to Section 28 0000 for additional information and requirements.

1.10 SUBMITTALS

A. Shop Drawings:

1. Refer to Section 28 0000 for additional information and requirements.
2. Provide a video surveillance camera schedule that includes for each camera all information in Video Surveillance Camera Schedule on the drawings, plus the following:
   a. Camera IP address
   b. Camera subnet mask
   c. Required PoE power, in watts

B. Certificates and Inspections

1. Refer to Section 28 0000 for additional information and requirements.

C. Operation and Maintenance Manuals

1. Refer to Section 28 0000 for additional information and requirements.
2. Provide a still image from each installed video surveillance camera:
   a. Obtained at full resolution at the time of final acceptance
   b. Scaled to and printed on a standard 8-1/2” x 11” sheet, one image per sheet
   c. Marked with text indicating camera’s unique alphanumeric identifier and network address

D. Record Drawings

1. Refer to Section 28 0000 for additional information and requirements.
2. For each video surveillance camera, indicate the following:

a. Installed location of camera
b. Direction camera is aimed
c. Camera's field of view
   1). Indicated by an isosceles triangle with it's apex at the camera and it's base at the vertical plane the camera is focused to.
      a). Length of base of triangle shall match the horizontal width of the field of view the camera is focused to.

1.11 GUARANTEE

A. Refer to Section 28 0000 for additional information and requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Section 28 0000 for additional information and requirements.

2.2 PRODUCT SUBSTITUTIONS

A. Refer to Section 28 0000 for additional information and requirements.

2.3 VIDEO SURVEILLANCE SYSTEM APPLICATION SOFTWARE

A. Existing to remain.

B. Manufacturer: Milestone

C. Provide new device licenses required to support all new cameras specified on project documents.

2.4 VIDEO SURVEILLANCE SYSTEM NETWORK VIDEO STORAGE

A. By Owner.

2.5 ETHERNET NETWORKING EQUIPMENT

A. By Owner.

2.6 VIDEO SURVEILLANCE CAMERAS

A. Type 1 - Flush Indoor Ceiling Mounted Fixed Dome Camera, 2 MP

1. Features:
   a. IK10-rated tamper resistant housing

b. Transparent dome
c. PoE powered
d. Wide dynamic range
e. Day/Night
f. Remote zoom and focus
g. Digital PTZ
h. Multi-view streaming
i. Built-in microphone
j. Supports two-way audio
k. Supports SD/SDHC/SDXC cards

2. Specifications:
a. Image Sensor: 1/3” RGB CMOS
b. Focal Length: 3 - 10mm, F1.4
c. Minimum Illumination, Color: 0.16 lux, F1.4
d. Minimum Illumination, B/W: 0.03 lux, F1.4
e. Shutter Time: 1/66500 - 1s
f. Camera Angle Adjustment, Pan: 360°
g. Camera Angle Adjustment, Tilt: 105°
h. Camera Angle Adjustment, Rotation: 190°
i. Video Compression: H.264
j. Resolution: 1920x1080 (2 MP)
k. Frame Rate: 30fps @ 60 Hz
l. Power Consumption: 8.2 watts max
m. Operating Temperature (Environmental): 32 - 122°F
n. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
o. Audio Input Connection: 1/8”, mic/line level
p. Audio Output Connection: 1/8”, line level
q. Alarm Input Connection: Terminal Block
r. Alarm Output Connection: Terminal Block

3. Basis of Design:
a. Axis P3375-LV

4. Acceptable Alternates:
a. None.

B. Type 2 - Flush Indoor/Outdoor Ceiling Mounted Fixed Panoramic Dome Camera, 6 MP

1. Features:
a. IP66-rated weather proof and IK-10-rated tamper resistant housing
b. Transparent dome
c. PoE powered
d. Wide dynamic range
e. Day/Night
f. Remote zoom and focus
g. Digital PTZ
h. Multi-view streaming
i. Supports two-way audio
j. Supports SD/SDHC/SDXC cards

2. Specifications:
a. Image Sensor: 1/1.8” RGB CMOS
b. Focal Length: 1.6mm, F2.0

c. Minimum Illumination, Color: 0.16 lux, F2.0
d. Minimum Illumination, B/W: 0.03 lux, F2.0
e. Shutter Time: 1/100 000 - 2s
f. Camera Angle Adjustment, Rotation: 360°
g. Video Compression: H.264
h. Resolution: 3072 x 2048 (6 MP)
i. Frame Rate: 30fps @ 60 Hz (6 MP), 60fps @ 60 Hz (2048x2048)
j. Power Consumption: 12.95 watts max
k. Operating Temperature (Environmental): -40 - 122°F
l. Network Connection: RJ-45, 10BASE-T/100BASE-T PoE
m. Audio Input Connection: 1/8", mic/line level
n. Audio Output Connection: 1/8", line level
o. Alarm Input Connection: Terminal Block
p. Alarm Output Connection: Terminal Block

3. Basis of Design:
   a. Axis M3057-PLVE

4. Acceptable Alternates:
   a. None.

2.7 MEDIA CONVERTERS

A. Features:

1. One channel of full duplex electrical to optical Ethernet conversion
2. 1000 Mbps fiber transmission via OS 2 single mode fiber optic SFP module
3. 10/100/1000 Mbps copper transmission via integral RJ-45 connector
4. IEE802.3at PoE+ output

B. Specifications:

1. Power Connection: Terminal Block
2. Optical Connection: SFP Slot
3. Copper Connection: RJ-45
4. Power Consumption: 35 watts at 48-57 volts DC
5. Operating Temperature (Environmental): -40 - 167°F

C. Basis of Design:

1. ComNet CNMCSFPPOE/M

D. Acceptable Alternates:

1. None

E. Provide complete with manufacturer's matching SFP module, power supply, and minimum of 24 hours of battery backup capacity.

2.8 CABLE

A. General

1. Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, the more stringent requirement shall govern.
2. Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed.
   a. Refer to Mechanical drawings for additional information and requirements.

3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

B. Video Surveillance Camera Cable

1. Ethernet Cable
   a. Refer to Section 27 1500 for information and requirements.

2. Low-Voltage Power Cable
   a. Minimum 18/2 unshielded
      1). Provide in gauge(s) as required to maintain no more than 10% voltage drop
   b. Basis of Design:
      1). Belden
   c. Acceptable Alternates:
      1). West Penn

3. Patch Cables
   a. Refer to Section 27 1600 for information and requirements

C. Media Converter Cable

1. Fiber Optic Cable
   a. OS2 single mode fiber optic cable
   b. Minimum 6 strands
   c. Refer to Section 271300 for additional information and requirements

2. Low-Voltage Power Cable
   a. Minimum 18/2 unshielded
      1). Provide in gauge(s) as required to maintain no more than 10% voltage drop
   b. Basis of Design:
      1). Belden
   c. Acceptable Alternates:
      1). West Penn

3. Patch Cables
   a. Refer to Section 27 1600 for information and requirements

2.9 UTP PATCH PANEL

A. By Division 27

B. Refer to Section 27 1500 for additional information.

2.10 RACEWAYS AND BOXES

A. Refer to Section 26 0533 for additional information and requirements.

B. Device Back Boxes

1. Dimensions: Minimum 4” square, 2-1/8” deep

C. Conduit

1. No flexible conduit of any type.
2. Minimum 3/4" trade size.

PART 3 - EXECUTION

3.1 CONFIGURATION AND PROGRAMMING COORDINATION MEETING

A. After all Section 28 2300 shop drawings have been approved, Contractor shall arrange and conduct a configuration and programming coordination meeting to review and coordinate all aspects of Video Surveillance device and equipment configuration and programming.

1. At a minimum, attendees shall include:
   a. Owner’s project manager and security representative
   b. Division 28 project manager and site superintendent / field foreman
   c. Video Surveillance subcontractor/supplier project manager and system programmer

2. At a minimum, meeting agenda topics shall include:
   a. Identification and review of each video surveillance camera, to include:
      1). Intended field of view
      2). Intended use for video
      3). Mounting location
      4). Camera type and mount type/configuration
      5). General configuration and programming
      6). Network address
      7). Configuration of recorded video (resolution, frame rate, etc.)
   b. Review of a product-specific configuration and programming guide detailing all configuration and programming options applicable to the system software, hardware, equipment, and devices being provided.
   c. Configuration and programming of system server(s) and workstations and of server/workstation graphical user interface screens
   d. Review of installation, configuration, programming, and testing schedule, and of how those relate to the overall construction schedule.

3. Meeting shall be held a minimum of two weeks prior to the commencement of work on site, and shall be scheduled with a minimum of two weeks’ notice.
   a. Contractor shall publish a meeting agenda for the meeting and distribute the meeting agenda and configuration and programming guide to all invited attendees a minimum of one week prior to the meeting.

4. Contractor shall take detailed notes during the meeting and publish meeting minutes within one week after the meeting. Minutes shall be distributed to attendees, the Architect, and the Engineer.

3.2 WORK SEQUENCE

A. Refer to Section 28 0000 for additional information and requirements.

3.3 BUILDING ACCESS

A. Refer to Section 28 0000 for additional information and requirements.

3.4 DAMAGE

A. Refer to Section 28 0000 for additional information and requirements.

3.5 DEMOLITION

A. Refer to Section 28 0000 for additional information and requirements.

3.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 28 0000 for additional information and requirements.

3.7 CLEANING AND REPAIR OF EXISTING MATERIALS

A. Refer to Section 28 0000 for additional information and requirements.

3.8 CONTINUITY OF EXISTING SERVICES

A. Refer to Section 28 0000 for additional information and requirements.

3.9 LOCATIONS OF WORK

A. Refer to Section 28 0000 for additional information and requirements.

3.10 EQUIPMENT ACCESS

A. Refer to Section 28 0000 for additional information and requirements.

3.11 EQUIPMENT SUPPORTS

A. Refer to Section 28 0000 for additional information and requirements.

3.12 SUPPORT PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.13 CUTTING AND PATCHING

A. Refer to Section 28 0000 for additional information and requirements.

3.14 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Refer to Section 28 0000 for additional information and requirements.

3.15 INSTALLATION

A. Refer to Section 28 0000 for additional information and requirements.

B. General

1. Integrate all new work under this project in to Owner's existing system.

C. Video Surveillance Cameras

1. Coordinate rough-in requirements with Division 26 Contractor prior to the commencement of work on site.
2. Coordinate all locations with Owner and Division 26 Contractor prior to the commencement of work on site.
3. Camera Mounting:
   a. Cameras and mounting accessories shall be rigidly attached to back boxes rigidly attached to structural members.
   b. Cameras installed in accessible ceiling tiles:
      1). Shall be supported by a tile bridge or other approved means
      2). Shall not be supported by the ceiling tile
      3). Shall be equipped with a safety cable secured to camera housing and structural member above
   c. Mount exterior cameras with stainless steel fasteners.

4. Provide surge suppression for all exterior cameras, including exterior cameras connected via media converters.
5. Provide media conversion for all cameras whose cabling exceeds maximum allowable length per applicable standards.
6. Cable, terminate, configure, program, test, adjust, and make completely ready for use.
7. Field-coordinate field of view, aim, and focus with Owner prior to commencement of final testing.
   a. Prior to final testing, Contractor shall, at no cost to Owner, make minor adjustments to camera locations and placement to address unanticipated obstructions to the field of view and/or unanticipated spatial interference.
      1). For the purposes of these adjustments, "minor" is defined as adjustments requiring relocation of up to six (6) feet from the location coordinated with the Owner during the Configuration and Programming Coordination Meeting.

D. Media Converters

1. Properly ground all media converter components and power supplies. Refer to Section 27 0526 for additional information and requirements.

E. Cable

1. All Video Surveillance System cabling shall be installed in conduit from device location to cable tray above nearest accessible ceiling.
2. Where work under this Section is installed in a pole, bollard, etc. on site shared by work under Division 26, all work under Division 26 in the shared pole, bollard, etc. shall be installed in metallic raceway and boxes from end to end.
3. Systems Identification:
   a. Label all system device cabling with unique alphanumeric identifiers that include:
      1). Video surveillance camera location:
         a). Exterior cameras - General location on site, based on direction (“North”, Northeast”, “East”, “Southeast”, etc.).
         b). Interior cameras - Architectural room number
      2). Unique alphanumeric identifier
   b. Refer to Section 27 0553 for additional information and requirements.

F. Configuration and Programming

1. Coordinate all configuration and programming with Owner.
2. Coordinate all IP address requirements with Owner a minimum of six weeks prior to commencement of programming work.

3.16 PAINTING

A. Refer to Section 28 0000 for additional information and requirements.

3.17 CABLE AND CONDUCTOR PROTECTION

A. Refer to Section 28 0000 for additional information and requirements.

3.18 TESTING

A. Refer to Section 28 0000 for additional information and requirements.

B. After successful completion of testing and prior to final acceptance, visually verify final field of view, aim, and focus of each video surveillance camera on site with Owner.

C. Visual Verification Follow-Up Visits

1. Contractor shall include in their bid a minimum of two (2) unique visits to the site to visually verify field of view, aim, and focus of each video surveillance camera with Owner.
2. Schedule of Visits:
   a. The first of these visits will occur within six (6) months of substantial completion, or at Owner’s request, whichever comes first.
   b. The second of these visits will occur within twelve (12) months of substantial completion, or at Owner’s request, whichever comes first.

c. Contractor shall tentatively coordinate scheduling for both visits upon substantial completion of work on site, but before final acceptance of the project.

3. At a minimum, Contractor shall provide for an average of ten (10) minutes per video surveillance camera installed under this project, or eight (8) hours for each visit, whichever is longer.
4. After each visit, Contractor shall prepare a report detailing observation of each camera's video and all adjustments made.
5. Contractor's bid shall include all labor costs associated with visits, to include:
   a. Off-site pre-preparation time
   b. On-site time
   c. Travel time
   d. Off-site report preparation time

3.19 START-UP

A. Refer to Section 28 0000 for additional information and requirements.

3.20 ATTIC STOCK

A. Refer to Section 28 0000 for additional information and requirements.

B. Contractor shall provide the following spare devices and equipment as Owner's attic stock:

1. Video Surveillance Cameras: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.
2. Video Surveillance Camera Mounts: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.
3. Media Converters: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.
4. Media Converter Power Supplies: 10% of the quantity installed of each type provided, minimum one (1) of each type provided.

3.21 DOCUMENTATION

A. Refer to Section 28 0000 for additional information and requirements.

3.22 CLEANING

A. Refer to Section 28 0000 for additional information and requirements.

3.23 TRAINING

A. Refer to Section 28 0000 for additional information and requirements.

B. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 1-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 282000

SECTION 283116 - MULTIPLEXED FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 14 2100 - Electric Traction Elevators

B. Section 21 1314 - Automatic Fire Sprinkler System

C. Section 21 1318 - Fire Protection Systems

D. Section 23 0993 - Control Sequences

E. Section 26 0000 - General Electrical Requirements

F. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

G. Section 26 0526 - Grounding and Bonding for Electrical Systems

H. Section 26 0533 - Raceway and Boxes for Electrical Systems

I. Section 26 0553 - Electrical Systems Identification

1.2 DESCRIPTION

A. In general, work consists of:

1. Furnish and install complete Multiplexed Fire Alarm System as shown on plans.
2. System shall:
   a. Be an intelligent analog system
   b. Allow for loading and editing special instructions and operating sequences as required
   c. Be capable of on-site programming to accommodate system expansion and facilitate changes in operation
   d. Be wired, connected, and left in operating condition

3. System includes:
   a. Control Panel(s)
   b. Annunciator Panel(s)
   c. Manual Stations
   d. Heat Detectors
   e. Smoke Detectors
   f. Alarm Indicating Devices
   g. Terminations
   h. Other necessary material for complete operating systems

4. Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

1.3 REFERENCE STANDARDS

A. NECA 305 - Standard for Fire Alarm System Job Practices

B. NFPA 72 - National Fire Alarm and Signaling Code

C. UL 268 - Smoke Detectors for Fire Protective Signaling Systems

D. UL 497B - Protectors for Communications and Fire Alarm Circuits

E. UL 521 - Heat Detectors for Fire Protective Signaling Systems

F. UL 864 - Control Units for Fire Protective Signaling Systems

G. UL 1480 - Speakers for Fire Protective Signaling Systems

H. UL 1481 - Power Supplies for Fire Protective Signaling Systems

I. UL 1711 - Amplifiers for Fire Protective Signaling Systems

1.4 QUALIFICATIONS

A. Equipment shall be supplied by company specializing in fire alarm and smoke detection systems with 5 yrs documented experience

B. Work shall be performed by licensed contractor, regularly engaged in installation and servicing of fire alarm systems.

C. Furnish proof of 5 yrs documented experience and factory authorization to furnish and install equipment proposed.

D. Contractor shall be located within 100 miles of Project site.

1.5 SUBMITTALS

A. Submit bill of materials listing part number and quantity of components and devices.

B. Submit general catalog cutsheets of all devices that are to be provided as part of system. Mark cutsheets with items specific to the project when multiple items are identified.

C. Submit block diagrams showing layout and operation of entire system.

D. Submit schematic diagrams, of circuits from field devices to terminal strip(s) associated with control panel.

1. Diagrams shall show schematic wiring of equipment; and connections to be made to devices.
2. Terminal connections in equipment shall be numbered to correspond to diagrams.
3. Wiring diagrams shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are same on drawings.

E. Submit standby battery power calculations.

F. Submit sound amplifier and strobe power supply calculations showing current draws for every device and module during standby, alarm and trouble conditions.

G. Submit voltage drop calculations for both initiating and alarming circuits.

H. Submit list of device addresses with location labeling as they will appear in 2 line, 40 character display of fire alarm panel and remote annunciator.

I. Submit to Authority Having Jurisdiction (AHJ):

1. Copy of shop drawings as required to show component locations.
2. Upon receipt of comments from AHJ, make resubmissions if required to make clarifications or revisions to obtain approval.
3. All fees associated with this shall be included in the bid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 SYSTEM OPERATIONS

A. Alarm Initiation

1. System alarm operation after activation of any manual station, automatic detection device, or sprinkler flow switch shall be:
   a. Appropriate initiating device circuit red LED shall flash on Control Panel and remote annunciator until the alarm has been acknowledged at Control Panel or remote annunciator.
   b. Once acknowledged, this same LED shall latch on.
   c. Subsequent alarm received after acknowledging shall flash subsequent zone alarm LED on Control Panel and remote annunciator.
   d. Acknowledgment of alarm shall not reset activated device.
   e. Pulsing alarm tone shall occur within Control Panel and remote annunciator until event has been acknowledged.
   f. Alarm audible-indicating devices shall sound in three pulse temporal pattern until silenced by alarm silence switch at Control Panel or remote annunciator.
   g. Visual alarm indicating devices shall operate in continuous flashing pattern until system is reset.
   h. Signal to notify the local fire department shall be activated.
   i. Doors held open by door control devices shall close.
   j. Mechanical controls shall activate air handling systems as specified by Division 23.

2. System shall have single key to allow operator to display alarms, troubles, and supervisory service conditions, including time and date of each occurrence.
3. Alarm shall be displayed on an 80-character LCD display as follows:
   a. 40 characters for:
      1) Point address and loop number
      2) Type of device

3) Point status
b. 40 characters for:
1) Custom location label

B. Silencing

1. Alarm audible indicating devices shall be silenced by operating alarm silence switch or by use of key operated switch at remote annunciator.
2. Strobes shall remain active until system is reset.
3. Subsequent zone alarm shall reactivate alarm signals.

C. Reset

1. SYSTEM RESET button shall return system to its normal state after an alarm condition has been remedied.

D. Supervision

1. System shall independently supervise:
   a. Initiating device circuits
   b. Sprinkler flow and tamper switches
   c. Independently fused indicating appliance circuits for alarm speaker/strobe units
   d. Auxiliary manual controls. "Off normal" position of any switch shall cause an "off normal" system trouble
   e. Auxiliary circuits for addressable relays. Blown fuse or open in circuit shall be visibly and audibly annunciated.
   f. Remote annunciator panel. Any ground, short, or open in the wiring to fire alarm Control Panel, as well as malfunction of the annunciator panel, shall be annunciated at control panel.
   g. Incoming power. Power failure shall be audibly and visually indicated at Control Panel and remote annunciator. Green "power on" LED shall be displayed continuously while incoming power is present.
   h. System Modules for module placement. Should modules become disconnected, system trouble indicator shall illuminate and audible trouble signal shall sound.
   i. System batteries. Low battery condition or disconnection of battery shall be audibly and visually indicated at Control Panel and remote annunciator.

2. Device activation shall be annunciated at Control Panel and remote annunciator.
3. Independently supervised circuits shall include visible amber "Trouble" LED to indicate disarrangement conditions per circuit.
4. Disarrangement conditions of any circuit shall not affect operation of other circuits.
5. Alarm activation of any initiation circuit shall not prevent subsequent alarm operation of any other initiation circuit.
6. System shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.

E. Power Requirements

1. Provide 120 VAC power via dedicated branch circuit in electrical panel.
2. Branch circuit shall have "breaker lock" to prevent accidentally de-energizing of power to fire alarm panel.
3. Circuit breaker shall be painted red and labeled "FIRE ALARM."
4. Provide disconnect switch for AC power near panel or within Fire Alarm Control Panel itself. Switch shall be labeled “Fire Alarm Power Disconnect.”

5. Provide power surge and transient protection.
6. Provide back-up battery capacity to operate entire system in normal supervisory mode for period of 24 h with 10 minutes of alarm operation at end of period.
7. System shall automatically transfer to standby batteries upon power failure.
   a. Battery charging and recharging operations shall be automatic.

8. Provide power limited, filtered and regulated battery charger.
   a. Charger shall:
      1) Be combination high rate/float maintenance type
      2) Charge fully discharged battery to 70% in 12 h
      3) Monitor for AC fail/disconnect, low/no battery, and high battery level
      4) Include switches and associated LEDs for high rate and AC disconnect
      5) Provide 5 amps of regulated 24 VDC for peripheral devices requiring ± 5% regulation and 8 amps at 24 VDC for standard peripheral devices.
      6) Be compatible with lead acid batteries

9. External circuits requiring system operating power shall be 24 VDC and shall be individually supervised and fused at Control Panel.

F. Smoke Detection Operation

1. Smoke detector alarms shall be processed and reported immediately.
2. Upon building completion, alarm verification shall be added to detector(s) as directed by project engineer.
3. Control Panel shall:
   a. Be capable of displaying number of times (tally) detector has gone into verification mode from the system history
   b. Download alarm set point to detector
   c. Determine condition of each detector by comparing detector's value to stored values.
   d. Maintain moving average of detectors' smoke chamber value to automatically compensate for dust and dirty conditions
   e. Continuously perform an automatic self-test routine on each detector
   f. Have capability of being programmed for pre-alarm or two-stage function
   g. Clear "detector dirty" trouble after detector has been removed from its base cleaned and replaced

4. System shall maintain constant smoke obscuration sensitivity for each detector by compensating for environmental factors.
5. Photoelectric detector's smoke obscuration sensitivity shall be adjustable to within 0.3% of either limit of UL window (0.5% to 4.0%) to compensate for any environment.
6. System shall indicate when individual detector needs cleaning. When detector's average value reaches predetermined level, trouble MESSAGE shall be audible and visibly indicated at Control Panel. LED on detector base shall glow steady giving visible indication.
7. For scheduling of maintenance, Control Panel shall generate MESSAGE indication for any detector approaching trouble condition due to dirt or contamination.
8. Operator shall have capability to manually access the following information for each detector:
   a. Primary status
   b. Device type
   c. Present average value
   d. Present sensitivity value selected
   e. Detector range (normal, dirty, etc.)

9. Values at Control Panel shall be in "percent of smoke obscuration" format, so that no interpretation is required by operator.
10. Operator shall be able to manually control following for each detector:
    a. Enable or disable detector
    b. Establish alarm sensitivity
    c. Control detector's relay driver output

11. It shall be possible to program Control Panel to automatically change sensitivity settings of each detector based on time-of-day and day-of-week. There shall be 3 sensitivity settings available for each detector.

G. Elevator Recall Operation

1. When an elevator lobby or machine room smoke detector alarm is activated it shall cause Phase I Emergency Recall Operation according to following sequence:
    a. If alarmed detector is on any floor other than main level of egress, elevator car(s) shall be recalled to main level of egress.
    b. If alarmed detector is on main level of egress, elevator car(s) shall be recalled to predetermined alternate recall level as determined by Owner.

2. Elevator lobby smoke detector shall annunciate on separate zone from other devices.
3. Zoning shall be done by floor.
4. Upon reset of Fire Alarm Control Panel, elevators shall automatically resume normal operations.

H. Elevator Shunt Trip

1. After elevator machine room or elevator shaft heat detector is activated, elevator control panel shall deactivate shunt trip breaker supplying power to elevator.
2. Specific elevator shaft zone shall be put into alarm and sound general fire alarm.

I. System Response

1. Maximum elapsed time from sensing fire at non-smoke detector initiating device or second smoke detector until it is recorded at Control Panel and remote annunciator shall not exceed 5 seconds, and not exceed 15 seconds for remote station reporting.

J. Air Handling Unit System Operation/Interface

1. Control Panel shall provide alarm interface to air handling/energy management system controllers, which shall perform automatic functions as specified in Division 23.
2. Engineer shall determine whether interface is to be at VFD/starters or via AHU/energy management system controllers.
3. Fire Alarm Control Panel shall provide manual control mode to override fire alarm panel's signal so that air handling units can be restarted.
4. New Fire Alarm Control Panel shall provide AHU fan shutdown functions identical to existing. Reconnect existing fan shutdown wiring to new panel.

K. Sprinkler System Operation/Interface

1. Activation of any standpipe or sprinkler system tamper or water flow switch shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator.

2. Control Panel shall provide differentiation between switch operation and opens and/or grounds on initiation circuit wiring.
3. Pressing acknowledge key will silence audible signal while maintaining supervisory service LED "on" indicating off-normal condition.
4. Restoring valve to normal position shall cause supervisory service audible signal to pulse indicating restoration to normal position.
5. Acknowledge key shall silence audible signal.

L. Manual Evacuation (Drill) Operation

1. Manual evacuation (drill) switch shall be provided to operate alarm indicating appliances without causing other control circuits to be activated.
2. Should true alarm occur, alarm functions would occur.

M. LED and LCD Test Operation

1. Activation of Lamp Test switch shall turn on all LED indicators, LCD display, and the local sounder and then return to previous condition.

N. System Diagnosis

1. System shall include special software to detect, diagnose and report failures and isolate such failures to printed circuit board level.

O. Watch-Dog Timers

1. System shall include independent "Watch-Dog" timers to detect and report failure of any microprocessor circuit, memory, or software.

P. Walk Test Operation

1. Actuation of "Walk Test" switch/program at Control Panel shall activate "Walk Test" mode of system, which shall cause following to occur:
   a. Fire department circuit connection shall be bypassed.
   b. Control relay functions shall be bypassed, such as door holders, elevator capture, fan shut down, etc.
   c. Audio and visual circuits shall be bypassed.
   d. Control Panel shall show trouble condition.
   e. Alarm activation of initiation device shall cause audible signals to sound for 2 seconds.
   f. Control Panel shall automatically reset itself after signaling is complete.
   g. Momentary opening of initiating or indicating appliance circuit wiring shall cause audible signals to sound for 2 seconds indicating trouble condition.
   h. If system becomes inactive for period of longer than 30 minutes, Control Panel shall default to normal fire alarm functions.
   i. Activation of any initiation device shall be silently logged as an alarm condition in historical data file.

2. Panel shall have capability of dividing system into distinctive walk test groups, minimum of 8 groups.

Q. One-Way Voice Communications

1. Automatic voice evacuation sequence shall be as follows:

a. Audio alarm signal shall consist of alarm tone for maximum of 2 seconds followed by temporal code-three. Temporal code-three shall sound until alarm silence switch at Fire Alarm Control Panel or the remote annunciator has been operated.
b. Audio alarm operations of speaker circuit selection and alarm tone timing variations shall be activated by system software so that required future changes to evacuation sequence or re-arrangements of audio circuits can be facilitated by authorized personnel without additional components or rewiring.
c. System shall be configured to allow for "All Call" from the main Control Panel and remote annunciator **panel.**

2. Selective Paging:
   a. Upon activation of any speaker manual control switch(es), 2 seconds of tone shall sound over selected speakers. At end of this tone, operator shall be able to make announcements via push-to-talk paging microphone over pre-selected speakers.
   b. Strobes shall flash only in selected area(s) or floor(s).
   c. Each floor, stairwell and elevator car shall be separate selectable zones.

3. All Call:
   a. Upon activation of "All Call" switch, 2 seconds of tone shall sound over all speakers in system. At end of this tone, the operator shall be able to make announcements via push-to-talk paging microphone over all system speakers.
   b. Strobes shall flash in all areas or floors.
   c. System shall default to normal operations if the microphone becomes inactive for more than 1 minute.

2.3 ENCLOSURE

A. Provide cabinets of sufficient size to accommodate equipment.

B. Cabinet shall be equipped with door, with lock and transparent door panel, providing tamper proof enclosure and allowing full view of various lights and controls.

2.4 CONTROL PANEL

A. Control Panel shall be modular, expandable with solid state, microprocessor based electronics.

B. Control Panel shall provide the following features:

1. Support intelligent (analog) detection devices.
2. **Ensure additional 10% spare capacity, in addition to other spare capacities required in this specification, is available in the Control Panel to serve a future 10,000 square foot building addition.**
3. Number of initiating device loops required for specified quantity of initiating devices plus 1 spare loop for each 5 active loops. Each active loop shall include **20%** spare capacity.
4. Number of indicating device (speaker) circuits required for quantity of speakers alarm, plus **1 spare circuit for each 10 active circuits**. Each active circuit shall include 25% spare capacity.
5. Number of indicating device (strobe) circuits required for specified quantity of strobes plus one **1 spare circuit for each 10 active circuits**. Each active circuit shall include 25% spare capacity.
6. 80-character liquid crystal display
7. Printer interface

8. History log file with minimum of 600 events
9. Field programmable
10. Drift compensation
11. Sensitivity display in %
12. Sensitivity adjustment
13. Day/night sensitivity adjustment
14. Auto detector test
15. Alarm verification with tally counter
16. Silent walk test
17. Maintenance alerts

C. System shall provide ability to recall alarms and trouble conditions in chronological order.

D. Under normal condition viewing window shall display "System is Normal" message and current time and date.

E. When an abnormal condition occurs appropriate LED (Alarm, Supervisory or Trouble) shall flash.

F. Audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

G. Panel shall display the following information relative to abnormal condition of a point in system prior to acknowledgement:

1. 40 characters for:
   a. Point address and loop number
   b. Type of device (i.e. smoke, pull station, water-flow)
   c. Point status (i.e. alarm, trouble)

2. 40 characters for:
   a. Custom location label (i.e. 4th Floor - Room 444)

H. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.

I. Following software functions shall be provided:

1. Setting of time and date
2. LED testing
3. Alarm, trouble, and abnormal condition listing
4. Enabling and disabling of each monitor point separately
5. Activation and deactivation of each control point separately
6. Changing operator access levels
7. Walk Test enable
8. Running diagnostic functions
9. Displaying historical logs
10. Point listing

J. Following hardware functions shall be provided:

1. Acknowledge alarm or trouble
2. Silence alarm or trouble
3. Reset system after alarm
4. Connect/disconnect fire department tie
5. Provide manual evacuation (drill)

6. Bypass elevator recall and shunt trip operation
7. Bypass door holders
8. Allow computer interface

2.5 STATUS INDICATORS AND DISPLAYS

A. Audible device shall sound during Alarm, Trouble or Supervisory conditions.

B. Audible device shall sound during each key-press.

C. Visual display shall distinguish between alarm, trouble and supervisory conditions.

D. Indicators and displays to be visible:

1. One red system alarm LED
2. One yellow supervisory service LED
3. One yellow trouble LED
4. Green "power on" LED
5. Eighty-character LCD

E. 2-line by 40-character LCD shall be backlit.

F. Cursor shall be visible on LCD when entering information.

G. Scrolling through menu options shall be in self-directing manner in which prompting messages shall direct user.

H. Controls shall be located behind an access door.

I. Status data to be available on display:

1. Initiating device circuits
2. Indicating device circuits
3. Auxiliary relays
4. Primary State of point
5. Zone information
6. Class "A" Status
7. Current priority of outputs
8. Disable/Enable status
9. Automatic/Manual Control Status of output points
10. Acknowledge status

2.6 CONTROLS

A. Controls (one switch per function per system) visible through front viewing window:

1. Alarm Acknowledge key
2. Trouble Acknowledge key
3. Alarm Silence key
4. System Reset key

B. Controls accessible with front door open:

1. **Fire department disconnect/switch**
2. Manual evacuation (drill)
3. **Elevator bypass**
4. **Fan shut down override/bypass switches**
5. Key pad for data input and microprocessor control

2.7 LED SUPERVISION

A. Slave module LEDs shall be supervised. When problem occurs, LCD shall display module and LED location.

2.8 ACKNOWLEDGMENT

A. Two methods of acknowledgment for each abnormal condition shall be provided:

1. Acknowledge one event at a time from an unacknowledged list of events.
2. Pressing acknowledge button shall display first unacknowledged condition in list (either alarm, supervisory or trouble), and require another acknowledge button. Press to acknowledge only displayed point.

B. After all points have been acknowledged, LEDs shall glow steadily and alarm will be silenced. Total number of alarms, supervisory and trouble conditions shall be displayed.

C. Pressing appropriate acknowledge button shall acknowledge all points

D. Acknowledge functions shall be behind locked door or pass-code protected.

2.9 SILENCING

A. If an alarm condition exists and "Alarm Silence" button is pressed, all alarm signals shall cease operation. Strobes shall remain active until system is reset.

B. If trouble conditions exist in system and "Trouble Silence" button has been pressed, audible trouble signal shall cease, but shall resound at timed intervals to act as reminder that fire alarm system is not in normal operating mode.

2.10 RESET

A. SYSTEM RESET button shall be used to return system to normal state after alarm condition has been remedied.

B. Should an alarm condition continue to exist, system shall provide indications that resetting can not be completed and shall remain in an abnormal state.

C. Sonalert and Alarm LED shall remain activated.

D. Display shall indicate total number of alarms and troubles present in system along with prompt to use ACK keys to review points.

E. Points shall not require acknowledgment if they were previously acknowledged.

F. Should Alarm Silence Inhibit function be active, system shall ignore all key presses. An indication of enabling and disabling inhibit state shall be provided as feedback to operator.

2.11 ACCESS LEVELS

A. Provide 4 access levels with level 4 being highest level. Level 1 actions shall not require pass-code.

B. Pass-codes shall consist of up to 5 digits.

C. Pass-code digits entered shall be displayed as an X to indicate that digit has been accepted.

D. Key presses shall be acknowledged by local audible sound.

E. When correct pass-code is entered, system shall indicate to operator "*Access Granted.”*

F. Access level shall be in effect until operator manually logs out or keypad has been inactive for 5 minutes.

G. Operator entering invalid code shall be notified with message *"Incorrect Pass- Code*" and shall be allowed three chances to enter valid code. After three unsuccessful tries, the message "*Access Denied*" shall be displayed.

H. Following keys/switches shall have associated access levels:

1. Alarm Silence
2. System Reset
3. Set Time/Date
4. Manual Control
5. On/Off/Auto Control
6. Disable/Enable
7. Programming functions
8. Clear Historical Alarm Log
9. Clear Historical Trouble Log
10. Walk Test

I. Acknowledge keys shall require pass code access to acknowledge points. If operator presses an (ACK) key with insufficient access, an error message shall be displayed.

2.12 POINT LISTING

A. Point list menu includes:

1. All points list by address
2. Monitor point list
3. Signal/speaker list
4. Auxiliary control list
5. Feedback point list

2.13 HISTORY LOGGING

A. System shall be capable of logging and storing the last 400 events (alarm and trouble) in history log. These events shall be stored in battery protected random access memory.

B. Following historical alarm log events shall be stored:

1. Alarms
2. Alarm Acknowledgment
3. Alarm Silence
4. System Reset
5. Alarm Historical log cleared

C. Following historical trouble log events shall be stored:

1. Trouble conditions
2. Supervisory alarms
3. Trouble acknowledgment
4. Supervisory acknowledgment
5. Walk Test results
6. Trouble Historical log cleared

2.14 COMPUTER INTERFACE

A. Control Panel shall operate as proprietary local system with capability of sending status data to and receiving control data from Central Processing Unit (CPU).

B. CPU shall monitor all alarms and troubles and control selected functions of Control Panel.

C. CPU shall supervise all data communication wiring between CPU and Control Panel for opens, shorts and grounds.

2.15 FIELD PROGRAMMING

A. System shall be fully programmable, configurable, and expandable in field and shall not require replacement of memory IC's.

B. Programming may be accomplished through Control Panel keyboard or keyboard at printer, or use of PC.

C. Programs shall be stored in non-volatile memory.

D. Programming or reprogramming shall be done by supplier at no charge until system is accepted by Owner.

2.16 TERMINAL/PRINTER INTERFACE

A. Control Panel shall be capable of operating remote monitors and/or printers.

B. Output shall be ASCII from RS-232-C connection with an adjustable baud rate.

C. Each RS-232-C port shall be capable of supporting and supervising up to 4 remote CRTs and Printers.

D. Data amplifiers shall be used to increase CRT or printer line distance.

2.17 INTELLIGENT NETWORK

A. System shall provide communications with intelligent initiating and control devices individually.

B. Devices shall be individually annunciated at control panel.

C. Annunciation shall include the following conditions for each point:

1. Alarm
2. Trouble
3. Open
4. Short
5. Device missing/failed

D. Devices shall have capability of being disabled or enabled individually.

E. There shall be no limit to number of detectors, stations, or addressable modules, which may be activated or "in alarm" simultaneously.

F. Multiple intelligent devices shall be connected to a single pair of wires.

G. Communication format must be completely digital poll/response protocol to allow t-tapping of circuit wiring.

2.18 ONE-WAY VOICE COMMUNICATION SYSTEM

A. Provide central audio control module for:

1. Alarm message/tone generation
2. Main and remote microphone connections
3. Mixer/pre-amplifier circuits
4. Continuous supervision shall be provided for all circuits, amplifiers and modules.

B. Hand-held, push-to-talk microphone:

1. Recessed in panel-mounted enclosure
2. Dynamic communication type with frequency range of 200 Hz to 4000 Hz
3. Equipped with self-winding 5’ coiled cable
4. LED indicator shall be provided to indicate microphone push-to-talk button has been pressed and speaker circuits are ready for transmission.
5. Supervised for disconnection

C. Audio control switch module:

1. Provide manual access to audio operations personnel.
2. Include "All circuits" switch, "Aux Tone" switch and tone generator stop switch
3. Switches and LED indicators shall be supervised for disarrangement on failure.

D. Automatic message player:

1. Provide a pre-recorded digitized voice message to building occupants during alarm conditions
2. Not rely on tape or other mechanical means of transmitting evacuation message
3. Be capable of transmitting a custom message of up to 3 minutes long

E. Self-contained speaker and switching arrangement shall provide testing of message(s) without disturbing occupants of the facility.

F. Provide standard message, approved by Authority Having Jurisdiction.

G. Audio power amplifiers:

1. Be furnished with self-contained filtered 24 VDC power supply, transformer and amplifier monitoring circuits
2. Provide 25 or 75 VRMS output with frequency response of 100 Hz to 7000 Hz
3. Be constantly monitored
4. Be current limited or disconnected from circuit should a short develop on speaker circuit
5. Individual speaker circuits shall not be loaded more than 70%of rated amplifier power output.

H. Provide amplifiers to operate system speakers at 1-watt tap simultaneously plus 50% reserve capacity.

I. Provide at least one back-up amplifier capable of automatically replacing any failed amplifier. Stand-by amplifier shall be rated at same output capacity as the largest amplifier in evacuation system.

J. Speaker and strobe circuits shall be zoned by floor or as noted on plans, with isolating module on each circuit.

K. Audio Evacuation Supervision:

1. Each speaker zone, amplifier, preamplifier, and power supply shall be supervised for component or circuit failure.
2. Detection of amplifier failure shall automatically cause substitution of stand-by amplifier and shall activate trouble light and audible signal at console and initiate trouble alarm on fire alarm system.
3. Provide minimum of one circuit for each zone or area of distinct communication.

L. Manual Voice Paging Sequence

1. System shall allow selective voice paging.
2. An "All Call" switch shall be provided to allow for activation of all speakers.
3. Control Panel shall provide a method for remote fire fighters telephone patch-in to one-way voice communication speakers.
4. Manual operation shall be controlled at Fire Alarm Control Panel, or remote microphone; if provided.

M. Tones

1. Main evacuating tone shall be temporal code-three.
2. Optional tones shall include:

a. Hi/Lo
   1) Free running tone with high frequency of 544 Hz and low frequency of 440 Hz
   2) "On time" (Hi) shall be 100 milliseconds while the "off time" (Lo) is 400 milliseconds.
b. Slow whoop
   1) Slowly ascending tone from 200 to 830 Hz in 2.5 seconds

3. One primary and one secondary tone generator shall be furnished.
   a. Automatic transfer to secondary unit should primary unit fail
   b. Trouble signals shall indicate a failure of either primary or secondary unit.

2.19 REMOTE ANNUNCIATOR PANEL

A. Provide 80-character LCD remote annunciator panel.

   1. LED annunciators will not be accepted.

B. Annunciator shall provide:

   1. Control push-button switches for; alarm silence, trouble silence, system reset and LED and LCD test.
   2. Tone Alert - Duplicates Control Panel tone alert during alarm and trouble conditions
   3. System trouble LED
   4. System alarm LED
   5. Power on LED
   6. **4 programmable control switches for other functions**
   7. **To accommodate and facilitate job site changes control switches shall have capability of being programmed on site to provide additional or nonstandard operations and functions.**

C. Annunciator shall communicate to Control Panel over one shielded twisted pair cable.

D. Operating power shall be 24 VDC and be fused at control panel.

E. Annunciator shall have white finish.

F. Wiring between annunciator panel and Control Panel shall be supervised for opens, grounds and shorts.

G. Under normal operating conditions, LCD shall indicate time, date and "SYSTEM IS NORMAL" label.

H. During abnormal conditions, LCD shall indicate type and number of abnormal conditions, such as alarms, troubles, and supervisory services.

2.20 MULTIPLEXED PERIPHERAL DEVICES

A. Devices shall be supervised for trouble conditions.

B. Failure of device shall not hinder operation of other system devices.

C. Device Identification

1. Each intelligent device shall be identified by an address code.
2. Location of end-of-line device shall be indicated on device that containing same.
3. System must verify that proper type device is in place and matches software configuration.

D. Intelligent Detector Bases

1. Either base or head shall contain electronic circuits that communicate detector's status (normal, alarm, sensitivity status, trouble) to Control Panel over two wires. Same two wires shall also provide power to base and detector.
2. Contacts between base and head shall be of bifurcated type using spring-type, self-wiping contacts.
3. Base shall have locking capability. Locking feature must be field removable when not required.
4. Upon removal of detector's head, trouble signal shall be transmitted to Control Panel.
5. Include for high rise buildings.
6. Detector base or head shall contain LED(s) that flash when detector is being scanned by Control Panel.
7. LED(s) shall turn on steady when detector is in alarm condition.

E. Intelligent Detector Heads - General

1. Intelligent detector heads shall be low-profile type.
2. Heads shall be plug-in units, which mount to common base.
3. Heads shall be 24 VDC type.
4. Heads may be reset by actuating Control Panel reset switch.
5. To minimize false alarms, voltage and RF transient suppression techniques shall be employed.
6. Smoke detectors:
   a. Listed for sensitivity testing from Control Panel. Sensitivity test results shall be logged and downloaded to printer.
   b. Include an insect screen.
   c. Communicate actual smoke chamber values to Control Panel.
   d. Covered with plastic bags after installation to maintain cleanliness. Bags shall be red for quick visual identification for removal at time of occupancy.

F. Intelligent Photoelectric Smoke Detectors

1. Detectors:
   a. Contain no radioactive material
   b. Be of solid state photoelectric type and shall operate on light scattering photodiode principle using pulsed infrared LED light.

G. Intelligent Carbon Monoxide Detectors

1. Detectors:
a. Electrochemical sensing cell. Provide CO sensing at minmum of 400PPM concentration with a maximum response time of 15 minutes.

~~G.~~**H.** Intelligent Heat Detectors

1. Detectors:
   a. Be a combination rate-of-rise and fixed temperature (135°F unless noted).

b. Sense within temperature range of 32° to 158°F. The control panel shall be capable of sensing either a set point of 135°F, or a rate-of-rise of 15°F per minute for fire sensing.

~~H.~~I. Intelligent Duct Smoke Detectors:

1. Duct detectors shall be of photoelectric type.
2. Detectors shall be rated for air velocity to be expected.
3. It shall be possible to alarm duct detector by using remote or local test switch.
4. It shall be possible to clean sampling tubes by access through duct housings front cover.
5. Provide relays adjacent to motor controller, and remote keyed test switch and alarm LED indicator.
6. In mechanical rooms, alarm LED indicators shall be grouped on a stainless steel cover plate.
   a. Mount adjacent to main mechanical room door.
   b. Each LED shall be labeled with detectors loop and address.
   c. Floor plan of room showing detectors and addresses shall be located adjacent to cover plate.
   d. Provide Plexiglas cover over plan.

~~I.~~J. Manual Stations

1. Manual stations:
   a. Double action
   b. Constructed of high impact, red Lexan with raised white lettering and smooth high gloss finish
   c. Contain circuits that communicate station's status (alarm, normal) to Control Panel over two wires
   d. Mechanically latch upon operation and remain so until manually reset. Stations that use Allen wrenches or special tools to reset shall not be accepted.
   e. Fitted with screw terminals for field wire attachment

2. Address shall be field programmable on station.

~~J.~~K. Interface Modules - General

1. Interface Modules:
   a. Receive 24 VDC power from separate two wire circuit
   b. Available in either Class B or Class A supervision version
   c. Supervised and identified by Control Panel
   d. Capable of being programmed for its "address" location
   e. Compatible with addressable manual stations and intelligent detectors on same intelligent initiating circuit

2. Class A wiring shall be looped back and connected to module.
3. Class B wiring shall be supervised by an end-of-line device.
4. Should interface module become non-operational or removed, trouble signal shall be transmitted to Control Panel.
5. Interface module LED's shall be clearly visible on the face of the trim plate.

~~K.~~L. Interface Modules - Supervised Control

1. Interface Modules shall be used for control of indicating appliances, door holders, and AHU systems.

2. For signals, speakers, fire fighter phone jacks and other device control interface module shall provide double-pole/double-throw relay switching that can connect any of the following through 2 amp fuses:
   a. Zone of signals to power source
   b. Speakers to audio source
   c. Fire fighter phone jacks to communications channel
   d. Variety of controlled devices to appropriate controlling circuits.

3. Interface modules:
   a. Communicate supervised wiring status (normal, trouble) to fire alarm control panel.
   b. Receive from fire alarm control panel command to transfer relay.

~~L.~~**M.** Interface Modules - Supervised Monitoring

1. Interface Modules:
   a. Suited for monitoring of water-flow, valve tamper, and non-intelligent detectors.
   b. Addressable interface module shall be provided for interfacing normally open direct-contact devices to an intelligent initiating circuit.
   c. Provide power to and monitor status of zone consisting of conventional 2-wire smoke or heat detectors and N/O contact devices.
   d. Communicate zone's status (normal, alarm, trouble) to Control Panel.

2. Supervision of zone wiring shall be Class B or Class A.

~~M.~~**N.** Interface Modules - Non-Supervised Control

1. Interface module shall provide double-pole/double-throw relay switching for loads up to 120VAC. It shall contain 2 amp fuses, one on each common leg of relay.

2.21 SPEAKER/STROBE DEVICES

A. Combination Speaker/Strobe Devices

1. Speakers:
   a. Operate on 24 V DC or 75 VRMS circuit
   b. Include separate wire leads for in/out wiring for each leg of associated signal circuit. T tappings of signal device conductors shall not be acceptable.
   c. Be suitable for rear mounting behind audio-visual assemblies, which shall be flush or semi-flush mounted, with manufacturer back boxes and flush trim ring.
   d. Have field adjustable output taps, 3 taps minimum.
   e. Provide minimum sound pressure level of 85.7 dBA at 10’ using 1-watt tap.
   f. Speakers located in mechanical room shall have 3 taps minimum with 8W being the highest.
   g. Provide a minimum sound pressure level of 90 dBA at 10’ using the 2-watt tap.
   h. For use in high ambient noise areas include f and g as appropriate and call out specific areas of use.
   i. Include a blocking capacitor for line supervision and screw terminal for in-out wiring.

2. Strobes shall be:
   a. Multi-tap units with taps at 15, 30, 75, and 110 cd.
   b. Tapped at 15-candela peak power or as noted on drawings.
   c. Have flash synchronization module on circuit when more than one strobe is visible at a time.

d. On separate supervised circuit from speaker circuit.

3. White cover with Lexan lens and shall have "FIRE" in red lettering visible from a 180° field of view.
4. Have white semi flush housing.
5. Strobe circuit loading shall be calculated at 75 cd tap for all devices, except in mechanical, interstitial spaces where circuit loading shall be calculated at 110 cd tap
6. Device shall be low profile
   a. Wall mount: 2.3” max depth housing with lens
   b. Ceiling mount: 2.9” max depth housing with lens

B. Speaker Devices

1. Speakers without strobe units:
   a. Include above-listed features
   b. Flush ceiling mounted white baffle and recessed back box for installation in suspended ceiling system.

2. Device shall be low profile
   a. Wall and Ceiling mount: 1.0” max depth housing

2.22 CONVENTIONAL PERIPHERAL DEVICES

A. Sprinkler Waterflow Switches - Wet Systems

1. To be furnished and installed by Fire Protection Contractor under Division 21.
2. To prevent false alarms, flow switch shall incorporate adjustable time delay mechanism between the paddle-operated stem and alarm initiating contacts.
3. Tapped 1/2” conduit connection

B. Sprinkler Valve Tamper Switches - Wet Systems

1. Sprinkler valve tamper switches shall be furnished and installed by Fire Protection Contractor under Division 21.
2. Switch shall be provided with either 1 or 2 sets of S.P.D.T. micro switches as required.

C. Fault Isolator Module

1. Provide Fault Isolator Module (FIM) on initiating device circuits in following situations:
   a. Loop extends to another floor
   b. For each 25 devices on a loop

2. Fault Isolator Module shall:
   a. Automatically re-connect isolated section of loop upon correction of fault conditions.
   b. Not require any address setting
   c. Operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.
   d. Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.

2.23 ISOLATED LOOP CIRCUIT PROTECTORS (ILCP)

A. Fire Alarm Control Panel shall include Isolated Loop Circuit Protector (ILCP) on circuits which extend beyond building. Circuits include, initiating device circuits, alarm notification appliance circuits, and signaling line circuits.

B. ILCP shall:

1. Be located as close as practical to point where circuits leave or enter building.
2. Have line-to-line response time of less than 1 nanosecond.
3. Have #12 AWG grounding conductor with maximum length of 25'. It shall be run in straight line and connected to building grounding electrode system.

C. Spark gap devices or devices incorporated in or installed within control panel in lieu of ILCP are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

A. Class B circuiting shall be used.

B. Installation shall be done in neat, workmanlike manner in accordance with manufacturer's recommendations.

C. Smoke detectors shall not be mounted until construction is completed.

3.2 RACEWAYS

A. Fire Alarm Panel risers shall be in conduit system separate from other building wiring.

B. Wiring shall be in conduit system separate from other building wiring. See Section 26 0533 - Raceway and Boxes for Electrical Systems.

C. Minimum 3/4" steel raceway.

D. Contractor shall size conduit and boxes by circular mil size of cable in conduit or box.

E. Surface access to existing alarm initiating circuits in public areas shall be via surface metal raceways (minimum equivalent to 3/4" conduit) and box extensions.

F. Existing conduit and surface metal raceway that are not 3/4" size may be reused if found to have adequate space for existing and new conductors.

3.3 CONDUCTORS

A. Cables and wires shall be provided per manufacturer shop drawings.

B. Conductors shall be color-coded. Coding shall be consistent through out facility.

C. Green wire shall be used only for equipment ground.

D. Control Panel power wiring shall be #12 AWG.

E. Control Panel shall have #12 AWG equipment ground wire.

F. Where fire alarm circuits enter or leave building, additional transient 75 to 90 V gas tube protection shall be provided for each conductor.

G. Cable Detector Loops shall be twisted pair with shield jacket. Shield shall be connected to earth ground only at control panel.

H. Detector wiring shall not be in same conduit with 120/240 VAC wiring or other high current circuits.

I. T-taps or branch circuit connections allowed for class B intelligent loop circuits.

J. Leave 8” wire tails at each device box and 36” wire tails at Control Panel and Remote Annunciator Panel(s).

K. Cable for RS 485 devices (Remote Annunciators) shall be shielded-twisted pair for data signal.

L. Wiring of initiating device circuits, alarm speaker circuits, and alarm strobe circuits shall be #14 AWG minimum.

M. Fire alarm cable shall be held in place at device box by means of 2-screw connector, (do not use squeeze or crimp type connectors).

N. Splices or connections shall be made within approved junction boxes and with approved fittings.

O. Boxes shall be red and labeled "FIRE ALARM SYSTEM" by decal or other approved markings.

P. Speaker and strobe circuits shall have separate conductors, and shall operate independently of each other.

Q. Tray cable is not acceptable for use as fire alarm systems raceway.

3.4 DEVICE MOUNTING

A. Recommended mounting heights, and requirements are as follows:

1. Fire Alarm Control Panels
   a. Mount control panel so visual indicators and controls at 60” above floor level.

2. Remote Annunciators
   a. Mount panel so visual indicators and controls at 60” above floor level.
   b. Install multi-gang box as required by manufacturer, flush mounted.

3. Audio-Visual Devices
   a. Install flush, semi-flush 6” below finished ceiling or 80” from bottom of device to finished floor.
   b. No devices protruding 4” or more shall be installed lower than 80”.
   c. Audio/visual devices may be installed on the ceilings in accordance with NFPA 72 - Table 2-A.

d. For surface mounting, use manufacture-supplied backboxes and trim plates.
e. Mark each device with its circuit number

4. Manual Stations
   a. Operable part of manual stations shall be installed not less than 3-1/2' (42") and not more than 4-1/2' (54") above finished floor.
   b. Manual stations shall be in unobstructed locations.
   c. For surface mounting, use manufacturers supplied backboxes and trim plates
   d. Mark unit's address on inside and outside of housing.

5. Heat and Smoke Detectors
   a. Location of detectors shown on plans is schematic only. Detectors must be located according to code requirements.
   b. Surface mounted detectors shall be installed using back boxes equal to base size. Standard octagon and square boxes are not acceptable.
   c. Detectors shall be located on the highest part of smooth ceiling so that edge of detector is no closer than 4" from sidewall.
   d. Ceilings with beams, joists or soffits that exceed 8" in depth require special planning and closer spacing.
   e. Mount detectors on sidewalls with top of detector no closer than 4" from ceiling and no further away than 12".
   f. Smoke detectors shall not be installed closer than 3' from air supply diffusers.
   g. No detectors shall be installed in direct airflow.
   h. Heat and smoke detectors should be located near center of open area, which they protect.
   i. Mark zone number and ranking of each detector on its base.
   j. For intelligent systems, mark address and loop number on each detector's base.

3.5 IDENTIFICATION LABELS

A. Junction boxes shall be painted red and labeled "Fire Alarm."

B. Circuits must be labeled with name of circuit and area being served by circuit.

C. Labels shall be permanent, and be machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

D. Labels shall be self-laminating, white/transparent vinyl and be wrapped around cable.

E. Flag type labels are not allowed.

F. Labels shall be of adequate size to accommodate circumference of cable being labeled and properly self-laminate over full extent of printed area of label.

G. Adhesive type labels not permitted except for phase and wire identification.

H. Wiring color code shall be maintained throughout installation.

I. Green wire shall be used only for equipment ground.

3.6 MANUFACTURER'S SERVICES

A. Supervision of installation shall be provided by trained service technician from manufacturer of fire alarm equipment.

B. Technician shall be US certified and have had minimum of 2 yrs of service experience in fire alarm industry.

C. Technician's name shall appear on equipment submittals, and letter of certification from fire alarm manufacturer shall be sent to project engineer.

D. Manufacturer's service technician shall be responsible for following items:

1. Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired.
2. Make periodic job site visits to verify installation and wiring of system.
3. Upon completion of wiring, final connections shall be made under supervision of technician.
4. At time of final checkout, technician shall give operational instructions to Owner and/or his representative.
5. Job site visits shall be dated and documented in writing and signed by Electrical contractor.
6. Discrepancy shall be noted on document and copy kept in system job folder, which shall be available to project Engineer any time during project.

3.7 TESTING

A. Manufacturer's authorized representative shall perform complete functional test of each system and submit written report to Contractor attesting to proper operation of completed system prior to final inspection.

B. Contractor shall test each device in system before system is considered substantially complete.

C. Completed fire alarm system shall be fully tested by Contractor in presence of Owner's representative and local Fire Marshal.

D. Upon completion of successful test, Contractor shall:

1. Certify system to Owner in writing
2. Complete NFPA 1-7.2.1 record of completion form
3. Provide as-builts and O&M manuals

3.8 WARRANTY

A. Warrant completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 2 yrs from the date of substantial completion of project.

B. Post warranty period along with company’s name and telephone number inside fire alarm panel.

C. Warranty service for equipment shall be provided by system supplier's factory trained representative.

D. Warranty shall include parts, labor, and necessary travel.

E. Occupied facility shall not be without UL and NFPA approved and fully operational fire alarm system for period longer than 2 h. Emergency response shall be provided within 2 h of notification, to contractor, of failure of system to perform operationally per UL and NFPA standards.

F. Non-emergency service calls shall be responded to within 24 h of notification to contractor.

G. Repairs and/or replacement shall be completed within 72 h of time of notification. Other than emergency, actual repairs and/or replacement shall be provided during normal working hours, Monday through Friday, excluding holidays.

H. If repair and/or replacement cannot be made within prescribed time, other means and methods of protection shall be provided to insure safety of building occupants during which time system is not in compliance with standards. This may involve up to and include hiring Owner approved qualified personnel to stand fire watch, at contractor's expense.

3.9 TRAINING

A. Contractor shall provide minimum of 4 h system operation training for Owner, Architect/Engineer, and fire department personnel.

B. Training session shall be at a time to be stipulated by Owner.

C. Training shall be completed prior to final inspection.

3.10 MAINTENANCE CONTRACT

A. Equipment manufacturer shall make available to Owner, maintenance contract proposal to provide minimum of 2 inspections and tests per year in compliance with NFPA-72 Codes.

3.11 SPARE PARTS

A. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

Quantity	Type of Device Present
10%	Photoelectric smoke detectors
10%	Heat detectors
10%	Smoke and heat detector bases
10%	Monitor Modules
10%	Control Modules
1%	Duct detectors with housing and sample tubes
1%	Speaker/strobe Units
1%	Speakers
1%	Strobes
1%	Manual Stations
1%	**Beam Detectors**

END OF SECTION 283116

SECTION 312113 – RADON MITIGATION

PART 1 - GENERAL

1.1 DEFINITIONS

A. Active Soil-Depressurization: The lowering of air-pressure in the soil, relative to the atmospheric pressure immediately above ground level.

B. Active Soil-Depressurization System: A system designed to lower the air-pressure in the soil beneath a building, relative to the atmospheric pressure immediately above ground level, by continuously withdrawing air from below a membrane covering the soil. An active soil depressurization system consists of a pressure distribution manifold, one or more radon vents, an operating fan, and a fan-failure indicator.

C. Contraction Joint: A formed or sawed groove in a concrete structure, extending normal to the surface and to a depth of at least one-fourth the thickness of a concrete element, for the purpose of creating a weakened plane that induces a crack as internal stresses develop due to drying shrinkage.

D. Construction Joint: The surface where two successive placements of concrete meet and are to be bonded; reinforcement is not interrupted, and tie bars are used as required.

E. Control Joint: See contraction joint.

F. Diffusion: The movement of radon from areas of high concentration to areas of low concentration.

G. Emanation: The gaseous elements produced by and given off from the radioactive disintegration of radium.

H. Equilibrium: The condition where the rate of decay of a radioactive parent isotope is exactly matched by the rate of decay of every intermediate daughter isotope(s).

I. Isolation joint: A non-bonded separation between adjoining parts of a structure, usually in a vertical plane, designed to allow relative movement in three directions in order to accommodate differential horizontal or vertical movement without the development of cracks elsewhere in the structure. May be either a butt joint or a lap joint, used to structurally separate the floor slab from other building elements.

J. Laitance: A layer of weak and nondurable material containing cement and fines from aggregates, brought by bleeding water to the outer surface of concrete.

K. Picocuries Per Gram: pCi/g, a measure of radioactivity corresponding to 0.037 radioactive disintegrations per second per gram of dry weight of a sample.

L. Picocuries Per Liter - pCi/L, a measure of radioactivity corresponding to 0.037 radioactive disintegrations per second per liter of volume.

M. Polyethylene Sheet: A thermo -plastic high-molecular-weight organic compound often used in sheet form as a water-vapor retarder also referred to as soil-gas-retarder-membrane.

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N. N. Radium (Ra): A naturally occurring radioactive element resulting from the decay of uranium. For the purposes of this standard, radium applies to radium-226. It is the parent of radon gas.

O. Radon: A naturally occurring, chemically inert, radioactive gas. It is part of the uranium-238 decay series. For the purposes of this standard radon applies to radon-222; thus, it is the direct decay product of radium- 226.

P. Radon Potential: A measure of the potential of soils at a building site for contributing to indoor radon concentrations.

Q. Soil-Gas-Retarder Membrane: A durable, flexible and non-deteriorating material, installed in a continuous sheet to retard the pressure-driven flow of soil gas through elements of a structure. For the purposes of these specifications, the Under-Slab Vapor Barrier is interchangeable with the use of term “vapor barrier”. See 072710 Under-Slab Vapor Barrier for Soil-Gas-Retarder Membrane specifications.

R. Working Level (WL): A measure of radioactive exposure equal to the total quantity of radon decay products in one liter of air that will result in the ultimate emission of 1.3 x 105 MeV (million electron volts) of energy from alpha particles. In perfect equilibrium, 1 WL equals 100 pCi/L (picoCuries per liter). It is often assumed that the air inside buildings is not in equilibrium, and that only half the radon daughters are moving freely in the air, while half are attached to dust or building surfaces. When this condition exists, an equilibrium ratio of 0.5 is said to exist. At an equilibrium ratio of 0.5, 1 WL = 200 pCi/L. For purposes of this standard, 1 WL is defined as equal to 200 pCi/L.

1.2 REFERENCES

A. United States Environmental Protection Agency Part 2 - Appendix B – Chapter 9B-52 F.A.C. Florida Standard for Passive Radon Resistant Construction

B. EPA 402-R-92-004, (1992) Indoor Radon and Radon Decay Product Device Protocols.

C. American Society of Testing and Materials International Standard Practice Designation E1465-07a-Standard Practice For Radon Control Options For The Design And Construction Of New Low-Rise Residential Buildings.

D. EPA 625-R-92-016, (1993; Am 1994) Radon Prevention in Design and Construction of Schools and Other Large Buildings.

E. Florida Standard for Radon-Resistant New Commercial Building Construction January, 1996

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 01 Specification Sections apply to this Section

B. Figure 1 – Building Soil Gas Conveyance System Design

C. Figure 2 – Vent Riser Pipe-to Ventilation Mat Connection

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1.4 SUMMARY

A. Section Includes:
   1. Radon ventilation mat.
   2. Sealing of penetrations.
   3. Vent piping.
   4. System testing.
   5. Related Sections:
      a. Division 03 Cast-in-Place Concrete for concrete slabs
      b. Division 07 Thermal and Moisture Protection, specifically Section 071710 Bentonite and Hydrophilic Waterstops, Section 072710 Under-Slab Vapor Barrier and Section 079200 Joint Sealants.
      c. Division 22 - Plumbing for radon vent piping systems.
      d. Division 31, Section 313116 Termite Control

1.5 PERFORMANCE REQUIREMENTS

A. Prepare substrate in accordance with the requirements set forth in Section 072710 – Under-Slab Vapor Barriers, Part 1.3, A.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification:
   1. For soil gas conveyance materials, submit sections of units not less than 12 inches square.
   2. ground cloth pins.

C. For Vent Stack Labels: Submit a reproduction of the proposed labels along with material of construction specifications.

1.7 INFORMATION SUBMITTALS

A. Product Test Reports:
   1. Based on evaluation of comprehensive tests of the vapor barrier material performed by a qualified testing agency demonstrating a Permeance of not more than 0.1 perms measured for Class A Requirements prescribed by ASTM Standard E 1745.
   2. An Under-slab Vapor Barrier Radon Diffusion Coefficient of not more than 1.3×10^{-13} m^2/second.

B. Qualification Data: For Post Construction Indoor Radon Testing - submit testing laboratory certification, for the laboratory performing radon detector analysis, meets requirements of the State of Florida and the National Radon Proficiency Program and/or the National Radon Safety Board (NRSB) for radon proficient devices and performed by individuals and Businesses Certified by the State of Florida Radon Measurement Specialist and Technicians qualified and authorized to perform such analysis and employed by State of Florida Certified Radon Measurement Business.

C. Diagnostic Testing Equipment: Submit proof of current calibration for testing devices used in performing post-construction indoor radon testing.

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D. Test Data: Based on evaluation of comprehensive tests performed by a qualified testing firm, for radon soil gas potential.
   1. Pre-construction Radon Soil Gas Potential testing
   2. Post- construction Sub-slab depressurization system testing

E. Record Drawings: Identifying and accurately showing locations of the Radon Vent Stack Locations.

1.8 QUALITY ASSURANCE

A. System Performance: Radon sub-slab depressurization (SSD) systems shall reduce and maintain radon concentration levels below 4.0 pCi/L (148 Bq/cu m) after activation of the SSD system.

B. Installer Qualifications: A firm that is acceptable to vapor barrier manufacturer for installation of vapor barrier required for this Project.

C. Source Limitations: Obtain radon soil gas conveyance materials through one source from a single manufacturer.

D. Mockups:
   1. Before beginning installation, install under-slab vapor barrier to following:
      a. Perimeter Footer form and any plinth wall that penetrates the depth of the slab and becomes a part of the finished slab grade.
      b. Single steel pipe
      c. Single Polyvinyl Chloride Pipe
      d. Ganged-pipes (multiple pipes/conduit strapped together and supported by a uni-strap or other solid material) to demonstrate execution quality.
      e. Spread footer
      f. Spread footer with plinth
      g. Joint between continuous linear sections of soil gas conveyance materials
      h. Installation of soil gas conveyance system material to be installed within 6-inches of slab penetrations.
   2. Before beginning installation of soil gas conveyance system material and gas venting system:
      a. Demonstrate proper joining and anchoring of mat segments.
      b. Proper joining and anchoring of independent linear segments of mat.
      c. Proper joining, anchoring and the protective system where independent segments of mat will be installed between sections of concrete placement.
      d. Proper installation of the required ventilation mat segments, anchoring of the Soil Gas Vent-to-Soil Gas Conveyance system, termination and labeling of post-concrete placement stub-up.

   If Architect determines mockups do not comply with requirements, re-apply vapor barrier and/or recreate the condition until mockups are approved.

   Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

E. Testing Agency Qualifications: Qualified according to requirements of the State of Florida Department of Health Radon Program for the testing indicated.

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1. Contractor Qualification: Individual responsible for diagnostic testing, field design and on-site construction supervision shall be recognized and approved by the State of Florida.
2. The General Contractor name and number, completion date of the project

F. Radon Professional Experience: Submit written evidence demonstrating that the Radon Professional has successfully designed and installed at least five radon mitigation systems of the same or similar type in the last five years.

G. The names, telephone numbers, email addresses, of the facility or installation for whom the radon resistant construction features and sub-slab ventilation system construction and/or testing was performed.
1. The name, telephone numbers, email addresses of the supervisory level point of contact at each facility or installation who has knowledge of the Radon Professional's performance.

H. Pre-installation Conference: Conduct conference at Project site. Review methods and procedures related to radon radon-resistant construction system including, but not limited to, the following:
1. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Field quality-control procedures.

I. On-Site Supervision: All Radon Resistant Construction work during installation of the radon resistant construction features and SSD system in a minimum of one building section (A, B, C, D and/or E) at the site shall be supervised by a person recognized by a State of Florida Department of Health as being experienced in performing construction-phase Radon Resistant Construction services in non-residential buildings.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing.

B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by soil gas conveyance material manufacturer.

C. Store rolls according to manufacturer's written instructions.

D. Protect stored materials from direct sunlight.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Soil gas conveyance system materials and slab penetration and vapor barrier sealing shall take place only when the surfaces to be joined are within the range of ambient and substrate moisture conditions recommended by vapor barrier manufacturer for achieving good sealing between sheets.

B. Soil Gas Conveyance System Limitations: Soil gas conveyance system shall be installed with filter media on the compacted substrate. The open web side of the material shall be kept free of foreign soils.

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1.11 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace soil gas conveyance material that does not comply with requirements.

B. Special Contractors Warranty: Contractor’s standard form in which the contractor agrees to replace soil gas conveyance materials that does not

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PART 2 - PRODUCTS

2.1 SOIL GAS CONVEYANCE MATERIALS AS FOLLOWS:

A. A radon venting product consisting of a nylon core of fused, entangled filaments with a geotextile heat-bonded to one or two sides.
   1. 18-inches wide, 0.08 inchs thick
   2. a demonstrated flow rate of 170 gpm/ft^2
   3. Permittivity of 2.31 sec-1 in accordance with ASTM D 4491, and;
   4. an Air Permeability of 400.0 CFM @ 0.5 Inches of H2O.
   5. 95% air space for much higher air flow than aggregate
   6. High compressive strength — able to sustain the load of a 12” concrete slab.

B. See Section 072710 Under-Slab Vapor Barrier and Section 079200 Joint Sealants.

C. Available Manufacturers and Products or equal:
   1. ColBond Inc.: Enkavent 6128®
   2. Other products meeting the requirements may be approved by the architect

D. The Contractor is responsible for verifying the actual material quantities required to complete the Radon Resistant Construction Features and SSD systems as well as all other material quantities necessary to complete construction.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary vapor barrier sheeting materials being 0.4 mil in thickness and a minimum of 22-inches wide to use as cover for soil gas conveyance materials that have only one side covered with filter media and the exposed webbing side of the material as it is installed to minimize dirt accumulation to maintain soil gas conveyance volume.

B. Vapor Barrier Ground Cloth Staples: Minimum, 9 gauge, galvanized “U” style, 9 inch long ground cloth staple.

C. Duplex head nails/scaffolding nails, of sufficient number, strength and length to secure the vapor barrier to form.

D. Flexible Elastomeric Thermal Pipe Insulation: Cut in 1-inch strips for creating a sealant pocket at all slab penetrations. (Alternative methods may be approved by the Radon Professional, but shall be proposed by the contractor prior to use.)

E. Radon Vent Pipe Labeling:
   1. Provide Removable caps and red masking tape 2” wide, minimum to temporarily mark the vent pipe stubs. Caps will be removed, and the vent pipe carried through the roof.
   2. Provide pressure sensitive nominal 2-inch wide by a nominal 11-inch long yellow band with the words “Radon Reduction System”, “Radon Soil Gas System” “Radon Air Flow” or similar language printed in black letters at least 1-inch in height. The label shall be durable, waterproof, brightly colored in a scheme not used in other systems in the building.

F. Tools and rags: Hammers, screw drivers and utility knives with a sufficient back up of blades to cleanly cut and tool vapor barrier as needed and a sufficient number of rags to clean pipes to facilitate sealing to create an air tight system.

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PART 3 –EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
   1. Verify that compacted subgrade is ready to receive soil gas conveyance materials.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates in accordance with architect and manufacturer's written instructions.

B. Clean substrates of substances harmful to soil gas conveyance system materials, including removing projections capable of puncturing soil gas conveyance system materials.

C. Remove areas of raised soils around all pipes and conduit that will penetrate the slab and clean the pipes to allow proper sealing.

D. Clean soils beneath all pipes and conduit tied together and secured by a uni-strut or other solid bar and clean the pipes and surfaces to allow proper sealing.

E. Protect and maintain benchmarks and survey control points from disturbance during construction.

F. Protect existing subgrade improvements from damage during installation of radon resistant system.

G. Restore damaged improvements to their original condition prior to installing the vapor barrier and after all sub-slab components of the radon system have been installed.

3.3 RADON MITIGATION SYSTEM INSTALLATION

A. SOIL GAS CONVEYANCE SYSTEM INSTALLATION
   1. To the extent feasible, the soil gas conveyance system materials (ventilation mat) shall be arranged as depicted in Figure 1 and detailed in Sheet A005. As indicated in Sheet A005, there are thirteen independent sub-slab ventilation pipe systems to be incorporated into the structure. In the event that unacceptable indoor radon concentrations are measured in one or more areas of the Building in the future, the system(s) beneath the affected area(s) can be converted into an active subslab depressurization system to actively exhaust radon beneath slab and control entry into the building.
   2. The vent mat shall be placed with the filter (typically white) material facing the compacted soil. Radon ventilation mats shall be installed immediately after the application of the termite control applications and immediately prior to placing the vapor retarder membrane, to reduce the chance for soil to enter and block the mat during construction of the soil gas conveyance system.
   3. As the vent mat is installed, it shall be secured to the soil base with 9 gauge, galvanized “U” style, 9-inch long ground cloth staples driven through the filter edge and linear webbing of vent mat runs and into the soil to secure in place. The ground cloth staples

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should be fully inserted through the sections of mat and driven into the soil until the pins are flush with the top of the mat. **DO NO OVER DRIVE SECURING PINS INTO THE MAT. IF PLACED TO TIGHTLY, AIR FLOW WILL BE ADVERSLEY IMPACTED.**

4. To further reduce the possibility of soil entering and blocking air-flow through the mat during construction, cover each liner foot of mat with a 22-24-inch wide strip of sacrificial polyethylene sheeting and slightly secure the outside edges in a crisscross/zip-zag pattern into the soil along the length of the mat spaced at approximately10-foot intervals per side of the polyethylene strip, so that the strip is secured approximately every 5-feet on one side or the other.
5. Sub-slab Mat Obstructions: To ensure free airflow along the length of the vent mat system, totally wrap the end of the mat with vapor retarder material, pin closed with common duplex head nails, which are then covered with tape approved for use in sealing the vapor retarder and pass the mat under obstructions such as construction joints and thickened portions of the foundation where such feature will not adversely impact slab performance. **No pipes shall penetrate the mat nor shall the mat be cut away to accommodate a pipe or any other soil penetration including concrete forms.** Mat obstructions shall be addressed on a case-by-case basis by the Radon Professional during mat installation and the system may be modified based on field conditions.
6. Radon Vent Mat Connections: Where sections of Radon Vent Mat join, the soil shall be removed to a depth of approximately 2-inches beneath the entire length (~12-inches) of the splice-only such that the specified slab thickness is maintained throughout. A minimum 12-inch long section of filter material at the end of one of the mat sections to be joined shall be loosened, but not cut away from the main section of mat and placed on the soil. The other piece of intact mat is to be inserted between the loosened filter material and the upper webbing (typically black) media of first section of mat. Both layers of the filter media should always cover the soil beneath the mat connection. The ventilation material (black woven material) shall then be manually compressed together to form an in initial connection.
    a. Prevent soil from collecting on and between the independent layers of mat to ensure non-obstructed air flow is maintained across the connection. Perform any necessary debris removal by lifting the mat and tapping on the back side of the mat until all soil has been removed or by vacuuming
    b. The mats will be pressed tightly together at this lap and mechanically attached together through both layers of mat with a minimum of five, 9-inch ground cloth staples driven through the overlapping sections of vent mat and filter media and into the soil to secure in place.
    c. The ground cloth staples used to secure all vent mat connections shall be distributed across the connection such that one ground cloth staple is located 2-3 inches from each of the four corners and one in the center of the mat splice and driven into the soil until the pins are flush with the mat. DO NO OVER DRIVE SECURING PINS INTO THE MAT SPLICE. IF PLACED TO TIGHTLY, AIR FLOW WILL BE ADVERSELY IMPACTED.
    d. Wire ties, which will puncture or tear the vapor retarder membrane, shall not be used to join the mats.
    e. Nails should not be used to secure the vent mat unless site conditions prohibit the use of ground cloth staples.
    f. When properly joined, the filter material will extend continuously under and across all slab joints and the full cross-sectional area of the mat will be preserved across the splice.

B. SOIL GAS VENTING AND FUTURE EXHAUST SYSTEM

1. GENERAL

    a. This scope of work does not mandate that electrical wiring or other equipment associated with activating the passive radon subslab ventilation system by installation

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of a exhaust fan. This information is provided for future planning purposes in the event that future indoor radon levels exceed 4 pico-curies of radon per liter of air.

2. SOIL GAS VENT PIPE TO VENTILATION MAT CONNECTIONS
    a. Radon vents are gas-tight pipes that carry the soil-gas to an area above and away from the building. Provide standard 3-inch by 4-inch closet flanges constructed of schedule 40 PVC, inverted from the normal installation orientation and an minimum 3-inch schedule 40, PVC ~12-inch high schedule 40 PVC pipe riser, which is independent of the closet flange to be stubbed through the slab surface to standard height of other slab penetrations once the flange is secured to the ventilation mat. Ensure the Radon vent pipes are constructed of a materials approved by the governing local building code for plumbing vents.
    b. Radon vents shall be distributed in a manner installed as indicated in the layout as indicated in Sheet A005 of the construction plans. Note if field-placement of the Radon Vent pipes interferes with other building components mandating an alternate location, the Radon Vent pipes shall be arranged in a pattern that provides at least two possible flow paths from any point in the system to a radon vent pipe. Alternate locations of Radon Vent pipes must be approved by the Architect and Radon Professional.
    c. At all Mat-to-Vent connections, the soil shall be removed to a depth of approximately 4-inches beneath the entire area of the connection to be made between the vent pipe flange and a minimum of 4 layers of mat, from which the filter media has been removed from the top three such that the specified slab thickness is maintained throughout to form the required vent stack assembly.
    d. The radon vent pipes shall be joined to the mat in a manner that does not restrict the full airflow capacity of the pipe by placing the open flat face of the closet flange directly on the center of previously prepared area of the mat and secured as indicated in Figure 2.
    e. Once the flange is secured in a manner that will allow the vent pipe to be installed and properly oriented, the pipe shall be solvent (primer and glue for PVC) welded to the flange to provide a gas-tight seal.
    f. The soil-gas-retarder membrane shall be fully sealed to the radon vent pipes in accordance with the provision of these Specifications.
    g. The radon vent stack stubs constructed of PVC shall be treated with approved mastic as required for all nonmetallic pipe penetrations.
    h. The top of the vent stub-up must be temporarily sealed with a removable rubber cap or tape and marked to indicate it is a Radon Vent Pipe as well as the Vent Pipe Identification Number.
3. SOIL GAS VENT PIPE INSTALLATION
    a. The diameter of the vent riser must be maintained throughout the entire length of the vent including the portion passed through the roof. Piping systems, which are part of the same vent mat system that are joined. Unless specified, radon vent pipes shall be carried through the roof independent of one another and shall not be joined unless authorized by the Architect.
    b. Radon vent pipes shall be solvent welded or otherwise joined to create a gas-tight connection from the soil-vent pipe assembly to the vent termination point.
    c. The radon vent pipes shall be sloped a minimum of 1/8 inch per foot in a manner that will drain all rain and condensate back to the soil and shall be supported in compliance with regulations for plumbing vents.
4. RADON VENT PIPE LABELING
    a. Radon Vent Pipe Labeling: All sections of the vent pipe shall be labeled prior to slab-placement and/or enclosing within walls or other building components to prevent accidental misuse, alteration or disconnection. Each section of Radon vent piping shall bear such labels placed at least every 3 feet throughout the length of all Radon Vent Pipes, including those portions behind walls or other enclosure and placed such that they are visible and legible from all directions.

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C. RADON VENT PIPE ROOF PENETRATIONS:
1. Roof penetrations shall be cut tight to the radon vent pipe such that the roof decking material is sealed to or as close to the pipe perimeter as possible to prevent re-entrainment of radon gas into the attic space.
2. All gaps between the perimeter of the vent pipe and the roof deck shall be sealed materials approved by the Architect and the roofing system manufacturer's specifications.
3. The radon vent pipes shall be fitted to the roof deck with a pre-fabricated rubber gasket/boot or other system capable of creating an air-tight seal according to the roofing system manufacturers' specifications and secured to the roof as required. To the extent feasible, vent pipe terminal pipes/frames shall be sealed to the deck according to the roofing system manufacturers' specifications.
4. The radon sub-slab depressurization systems shall be capped until such time as the building construction is compete or indoor radon concentrations deem passive operation or activation of the system as directed by the Building Owner.
   a. Vent pipe terminations shall be secured with an air tight cap. PVC pipe shall be capped and secured in place with PVC primer and glue or a flexible cap such as that manufactured by Fernco Qwik Caps, secured in place with stainless steel pipe clamp per the manufacturers specifications.
   b. At such time, as it is determined the system, or a portion of the system must be operated passively or actively, radon vent pipe caps shall be removed as necessary.

F. RADON VENT PIPE TERMINALS
1. The radon vent pipes shall terminate such that there are no obstructions to upward air flow. Fitting terminations located a minimum of 10-feet from any operable openings including exhaust fans with a PVC "T".
2. The vertical pipe terminal may be covered with a screen mesh, strong enough to prohibit entry by wildlife.
3. The screen shall be secured to the pipe opening may be required.

3.4 FUTURE RADON EXHAUST FANS PLANNING FOR POTENTIAL ELEVATED INDOOR RADON LEVELS

A. GENERAL REQUIREMENTS
1. The potential exists for radon levels to increase beyond that measured post construction due to structural changes made to the building, including any work, which would require the building slab to be cut or the foundation repaired or added onto, changes to the air conditioning systems or a change of functional use. Therefor this specification is for future planning purposes only.
2. A suitable workspace platform, a means of powering an radon exhaust fan and monitoring equipment, electrical wiring and the equipment required to operate a radon ventilation fan performance monitor (on-off) shall be installed during construction to allow for future installation of a radon exhaust fan if a section or more of the soil-depressurization system is required to be commissioned to depressurize the sub-slab environment in the future, i.e. if indoor radon levels exceed guidelines. This could be as simple as pull strings extended from the location where an alarm could be easily seen or heard in the occupied building to each future exhaust fan location.
3. Future soil-depressurization system exhaust fans shall be designed to maintain 0.5 inches water-column at a minimum.

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4. If future post construction indoor radon levels exceed 4 pico-curies per liter of air in any area of the building, contact the Radon Professional for assistance with specification of an active depressurization system and exhaust fan sizing.

3.5 FUTURE SUB-SLAB DEPRESSURIZATION SYSTEM EXHAUST FAN-FAILURE INDICATOR DEVICE

1. A fan-failure monitoring system shall be commissioned upon the activation of the systems(s) to automatically indicate failure of a system(s) to building occupants.
2. If the passive subslab system must be converted to an active subslab depressurization system, equipment required to activate a fan-failure monitoring device shall be installed for each radon vent pipe to be activated in the location where a radon exhaust fan is installed.
3. If future post construction indoor radon levels exceed 4 pico-curies per liter of air in any area of the building, contact the Radon Professional for assistance with specification of an active depressurization system and fan-failure monitoring device.

3.6 SEALING JOINTS, OPENINGS IN CONCRETE INTERIOR FLOORS AND WALLS

A. GENERAL

1. Provide sealants according to requirements in the Architects Specifications for "Joint Sealants" for slab-on-grade joints and openings.

B. SEALING JOINTS, OPENINGS IN CONCRETE INTERIOR FLOORS AND WALLS

1. Contraction Joints: All contraction joints shall be cleaned and sealed against soil-gas entry by use of an approved sealant applied according to the manufacturer's instructions.
2. Horizontal joints: Between two slabs of different elevations shall provide horizontal contact between the two slabs that is at least 8 inches wide, or shall be sealed by an approved sealant. Horizontal joints which are created between two slabs that are poured at different times shall be sealed by an approved sealant.
3. Vertical Joints: Through-slab vertical joints shall be formed prior to concrete placement or postcure saw-cutting with a recess of not less than 1/4 inch by 1/4 inch such as would be created by a closed-cell joint forming material and after the concrete slab has cured shall be sealed with an approved sealant.
4. Butt Joints: The sealant reservoir is to be created by securing a spacer material to the existing slab edge or wall prior to concrete placement. Once the slab is cured, the spacer material shall be removed to depth and the joint sealed with an approved sealant.
5. Lap joints: All non-bonded lap joints shall be sealed with either a field molded or preformed elastomeric sealant or with flexible closed-cell water stop as specified for Butt Joints. The lap joint shall be shall be sufficiently large to prevent failure of the sealant or water stop, but in no case be shall the sealant reservoir be less than 1/2 inch by 1/2 inch in cross section. The sealant reservoir is to be created by securing a spacer material to the existing slab edge, frame or wall prior to concrete placement. Once the slab is cured, the spacer material should be removed to depth and the joint sealed with an approved sealant.
6. Large utility service openings: through the slab shall be gas tight by fully covering the exposed soil with a soil-gas-retarder-membrane, covered to a minimum of 1 inch with an elastomeric sealant. Alternatively, the openings may be sealed with expansive concrete or hydraulic cement to within 1/2 inch of the top of the pan? and the remaining 1/2 inch filled with elastomeric sealant.
7. Hollow Masonry Walls: All openings for electrical boxes or plumbing or other wall penetrations in hollow masonry perimeter walls shall be sealed in order to reduce radon entry, with an approved caulk and/or gasket on the interior face of the wall.

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8. Sump(s): located in the habitable portion of the building and connecting to soil either directly or through drainage piping, shall be fitted with a lid, which is sealed to the sump perimeter with a gasket/seal. The lid shall be attached so as to provide a gas tight seal between the sump and the access space above.

C. SEALING OF SLAB PENETRATIONS AND CRACKS

1. Stake Penetrations: Any stake that extends through more than 1/4 the thickness of the slab shall be of a non-porous material resistant to decay, corrosion, and rust, and shall be cast tightly against the slab, or sealed to the slab with an approved sealant. All stakes shall either be solid, or shall have the upper end tightly sealed by installation of an end cap designed to provide a gas-tight seal.
2. Workspaces formed into a slab: All workspaces such as beneath a shower or bathtub drain shall be sealed gas tight. The exposed soil shall be compacted and then shall be fully covered with solvent based plastic roof cement or other approved elastomeric material to a minimum depth of 1 inch.
3. Pipe Penetrations: All pipes shall be in contact with the slab along the slab's depth by casting the concrete tightly against the pipe. Where pipes are jacketed by sleeves (plastic or other) they shall be sealed by one of the following methods:
   a. Formation of a slot in the slab around the pipe and casting with an approved sealant from the slab to a point above the sleeve, or:
   b. Seal the space between the sleeve and the pipe with an appropriate joint sealant.
   c. Pull/melt excess jacket material out from space between the pipes and slab and fill the annular space between the jacket and the top of the slab with an approved sealant.
4. Pipes and wiring penetrating the slab through chases or conduit: shall be sealed by placing an approved sealant between the pipe or wiring and chase or conduit. Plastic sheath, foam or insulation material shall not be used alone around pipes or conduit for sealing purposes.
   a. Where multiple pipes are ganged, block-out a workspace around the multiple pipes, fit to the extent feasible with vapor barrier material and seal with an approved tape or sealant.
   b. Plastic plumbing pipes and electrical conduit may be coated with compatible approved fibered roofing or bituminous mastic from the soil base through the entire slab depth to assist in achieving a tight seal through the depth of the slab.
   c. Once the slab has cured around plastic piping or electrical conduit, the perimeter joint between the pipe perimeter and the concrete shall be sealed with an approved sealant.
5. Cracks: All slab cracks 1/32 inch wide or greater that exhibit vertical displacement; all cracks that connect weakened zones in the slab such as vertical penetrations or re-entrant corners; and, all cracks that occur cross changes in materials or planes in the structure, shall be cleaned and sealed against radon entry, prior to applying floor covering, with a flexible field-molded elastomeric sealant installed in accordance with the manufacturers requirements.
6. Random cracks less than 1/32-inch in width that do not meet any of the above criteria may be left unsealed.

3.7 SEALING OF HVAC SYSTEM COMPONENTS

A. GENERAL

Condensate drains and pipe and conduit chases for refrigerant lines that provide a direct connection between the indoor air and the soil shall be sealed in accordance with the provisions of this specification and shall be treated as any other slab penetration.

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B. CONDENSATE DRAINS AND CHASES
   1. Condensate Drains: Condensate drains shall connect to air outside the building perimeter at a height of at least 6 inches above the finished grade ground level. Chases through which the condensate and refrigerant lines run shall not terminate in the air return plenum or duct. If a portion of the condensate pipe does not drop below the height of the condensate outlet, then a trap should be installed to prevent suction of outdoor air into the air handler.
   2. Refrigerant Pipe and Conduit Chases: Refrigerant pipe and conduit chases that terminate within the building shall be sealed with a bituminous closed cell material or other material approved by the Architect. Pipe insulation shall be removed from the refrigerant lines at the point of the seal to provide for complete bond between the refrigerant line and the approved sealant material.

C. SEALING OF DUCTS AND PLENUMS, MECHANICAL SYSTEM CONNECTIONS
   1. Sealing: All ducts and plenums shall be sealed in order to achieve acceptable indoor radon concentrations and shall be made airtight in accordance with the "Florida Energy Efficiency Code for Building Construction". If duct board is used, the seal must be on the foil side of the duct board. Mastic sealing systems designed specifically for the conditions of use shall be used in accordance with the manufacturer's recommendations to close and seal leaks in ducts or plenums. Modifications to ducts located in service areas of attics shall incorporate support, cover or other protection from accidental damage.
   2. Return Air Plenums: shall be constructed with materials and closures, which produce a continuous air barrier for the life of the building. Construction of the return plenum shall be done such that a continuous air barrier completely separates the plenum from adjacent building structures. If duct board is the primary air barrier, then the joints shall be sealed by fabric and mastic on the foil side of the board.

3.8 FIELD QUALITY CONTROL

A. Radon Sub-slab Ventilation System Inspection: Each complete soil gas conveyance and passive venting system shall be inspected prior installation vapor barrier by a person recognized by the State of Florida Department of Health as being experienced in performing construction-phase Radon Resistant Construction services in non-residential buildings.
B. On-Site Quality Assurance Inspections: A person recognized by the State of Florida State of Florida Department of Health as being experienced in performing construction-phase Radon Resistant Construction services in non-residential buildings shall inspect the completed vapor barrier and soil gas venting terminals prior to the placement of each slab section in order to confirm all of the Radon Resistant Construction features and SSD system have been properly installed to optimize the potential success of controlling post-occupancy indoor radon throughout the structure.
C. The Radon Professional shall inspect the exhaust fan installation and maintenance platform to ensure an exhaust fan can be installed with required clearances in the event the passive system must be activated in the future.
D. The Radon Professional shall inspect the means used to ensure electrical wiring from an independent breaker to the exhaust fan workspaces can be easily installed if required in the future.
E. The wiring or other equipment required to operate each radon exhaust fan shall be identified and the Radon Professional shall confirm the equipment extends from the workspace where any future exhaust fans may be installed and maintained to the location where the fan-failure indicator will be located if required in the future.
F. The workspaces shall be completed prior to closing the area above the ceiling line or otherwise obstructing the workspace platform from view from below.

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3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. GENERAL

1. Remove surplus material, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

2. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 312113

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SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include the EPA-Registered Label for termiticide products.
2. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed to apply termite control treatment and products and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.7 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.8 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. BASF Corporation, Agricultural Products; Termidor. (Fipronil)
2. Bayer Environmental Science; Premise 75. (Imidacloprid)
3. Or equal.

B. Service Life of Treatment: Soil treatment termiticide that is effective for not less than **five** years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLICATION – GENERAL

A. General: Comply with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
3. Crawlspaces: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.

5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

3.5 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

C. Post warning signs in areas of application.

D. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.6 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of termite-control-treatment Installer. Include annual maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 313116