Project Manual – Book No. 2 of 2

Plumbing, HVAC, Electric and Electronic Safety and Security

SOUTHGATE PUBLIC SCHOOL RENOVATIONS

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Southgate, Kentucky 41071

SOUTHGATE INDEPENDENT BOARD OF EDUCATION

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REH&A ARCHITECTS

KLH Engineers, P.S.C. **Mechanical/Electrical Engineers**

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Project Manual – Book No. 2 of 2

Plumbing, HVAC, Electric, and Electronic Safety and Security

Division 22 – Plumbing

Division 23 – Heating, Ventilating and Air Conditioning

Division 26 – Electric

Book No. 1 of 2 **Bidding Documents, Contract Documents and Division 01**
Divisions 02 through 10 and 32: Architectural and Site

SECTION 220170 - OPERATION AND MAINTENANCE OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Closeout Submittal

1. Operation and Maintenance Manuals: Include operation and maintenance manuals for all fixtures, equipment, and systems specified under Division 22.

A. Shop Drawings

1. As-Built Drawings: For recording installed conditions that deviate from design documents.

1.2 OPERATING AND MAINTENANCE MANUAL

A. The contents of operating and maintenance manual shall include the following:

1. Project Information Cover: Title of Project; Name and address of Owner, Design Professionals, Contractor of Record and Subcontractor; System name and specification references.
2. Index: Contents of the manual.
3. Warranty Statements: Furnish a warranty statement for each system, reiterating the terms of warranty identified within the Contract Documents, and identifying how the Owner is to obtain warranty service. Clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 1-year parts and labor). Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion. Supply standard out-of-warranty service rates and service contact information.
4. Bill of Materials: List of products supplied, and serial numbers of each product.
5. Product Datasheets and Shop Drawings: Manufacturer datasheets and shop drawings for each product and system supplied.
6. Manufacturer Owner / User Manuals: Manufacturer’s Owner’s or User’s manual for each product, and Manufacturer’s Installation instructions and other documentation supplied with the product.
7. Spare and Replacement Parts Schedule:

    a. Complete spare parts schedule for components of equipment furnished, which are not factory generic information, but accurate for the equipment provided.

8. Maintenance Procedures: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; testing, aligning and adjusting instructions.
9. Function and Operating Descriptions: Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

10. Operating Procedures: Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.
11. Test Reports and Checklists: Test reports, checklists, and other forms generated and completed for the Project.
12. Training Information: Copy of training outlines/agendas, training session handouts, training sign-in sheets, and signed delivery receipt for each training session recording; Separate USB drive, labeled, for audio/video-recorded instructions to Owner, for operations and maintenance for each system.
13. As-Built Drawings.

    a. Valve-tag schedule shall also be included in operation and maintenance data.

1.3 AS-BUILT DRAWINGS

A. Obtain two complete sets of electrical prints and use them to provide progress record drawings which are separate, clean, prints reserved for the purpose of showing a complete picture of the work as actually installed (including routing of conduit and cables). These drawings also serve as work progress report sheets. Make notations, neat and legible thereon daily as work proceeds. Make these drawings available for inspection at all times and keep them at the job at a location designated by the Owner's Representative.

B. Maintain the clean, undamaged set of prints of drawings as well as a set of submittal drawings and coordination drawings. Mark the sets to show the actual installation where the installation varies from the Documents as originally shown. Include locations of underground and concealed items if placed other than shown on the Documents. Where shop drawings are used, record a cross-reference at the corresponding location on the Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

C. Show changes in: size, type, capacity, etc., of material, device or piece of equipment, location of device or piece of equipment; location of outlet or source of building service systems; routing of piping, conduit, or other building services. Record location of concealed equipment, electrical service work, conduits and other piping/work by indication of measured dimensions to each line from readily identifiable and accessible walls, column lines or corners of building. Indicate approved substitutions, modifications, and actual equipment and materials installed.

D. Affix near the titleblock on each drawing the Contractor’s Company Name(s), signature of Contractor’s Representative(s) and current date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTRUCTION OF THE OWNER’S PERSONNEL

A. Provide instruction in the proper operation and maintenance of equipment that requires routine servicing. Include the following:

1. Review of operation and maintenance manuals.
2. Required tools.

3. Lubricants.
4. Spare parts.
5. Cleaning.
6. Hazards.
7. Warranties and maintenance agreements.

B. Demonstrate equipment and systems operation including the following:

1. Start-up.
2. Shut-down.
3. Emergency conditions.
4. Safety procedures.
5. Setpoint and schedule adjustments.
6. Economy and efficiency adjustments.

END OF SECTION 220170

SECTION 220501 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Shop Drawings

1. Coordination Drawings: This contractor shall provide necessary coordination drawings required to make sure all disciplines are coordinated and fit into specified spaces (i.e. ceilings, chases, and all others). It is the work of the contractor to prepare complete coordination drawings indicating exact location, clearances and penetrations of all items of all trades.

1.2 GENERAL DIRECTION

A. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and had an opportunity to visit the site to be able to provide a comprehensive complete bid.

B. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes. Interpret these specifications in conjunction with the drawings and provide all work described. If work is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both. Should there be a conflict between the specifications and drawings, provide the greater quantity or better quality. Immediately notify owner’s representative and design professional of such conflicts.

C. The drawings that accompany these specifications are diagrammatic and although size and location of equipment is drawn to scale wherever possible make use of submittal data and verify all dimensions on site. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Follow the drawings as closely as is practical and install additional bends, offsets and elbows where required by site conditions and codes at no additional cost. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, all measurements should be taken in the field.

D. Coordinate all work with all other contractors and installers in addition to existing building obstructions and install accordingly. Comply with requirements of architectural drawings including but not limited to mounting height and locations. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

E. Complete work, or part(s) thereof, at times as may be designated by the Owner's Representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of it by Owner.

F. During mobilization or construction, if an abnormal condition is uncovered either with existing conditions, equipment loads, submittal data, etc. bring these to the attention of the Design Professional for review.

G. Owner's Representative or Design Professional may relocate devices prior to installation within a 20-foot limit at no additional charge.

H. All piping shall be run as straight as possible and symmetrical with architectural items. Piping shall be concealed in pipe shafts, pipe spaces and furring wherever possible. Piping installed before coordination with the other trades will be done at the contractor's risk.

1.3 GENERAL STANDARDS

A. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest edition of applicable standards and adopted codes, including (but not limited to) the following.

1. State Building Code and applicable local amendments.
2. Local Building Code (if applicable)
3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
4. American Society of Test Materials (ASTM)
5. National Fire Protection Association (NFPA)
6. Underwriters Laboratories (UL)
7. American Gas Association (AGA)
8. National Sanitation Foundation (NSF)
9. American National Standards Institute (ANSI)
10. National Electric Code (NEC)
11. Building Code Seismic Relative Displacement Requirements

1.4 PERMITS AND REGULATIONS

A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this branch of the work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.

B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor and are hereby made a part of this contract.

1.5 DEFINITIONS

A. Furnish - Procure, supply and deliver to project site, ready for installation, install and warrant (unless indicated otherwise on documents). Include warranty expenses.

B. Install - To supply labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order render the respective product and system fully operational and usable to the Owner for the intended purpose

C. Provide - Furnish and Install. Similar Terms: "include", “shall”, “equip with”, “consisting of”.

D. Equal or Equivalent - Determination of equivalency to be made by design professional for all products not listed as basis-of-design.

E. Substantial Completion - Where frontend documentation does not define, products and systems must be fully installed as designed, tested, adjusted, labeled, and functionally demonstrated to owner.

1.6 REQUESTS FOR INFORMATION

A. Submit all questions, requests for information (RFIs) and similar queries through the formally-established RFI process for the project that has been accepted by the Owner's Representative, Design Professionals, Prime Contractor and subcontractors. Submit as a PDF file. Do not submit as text in an email.

1.7 AVAILABILITY OF ELECTRONIC DRAWINGS

A. If expressly permitted by the Owner and the terms of the Contract, editable electronic drawings may be made available for the creation of shop and as-built drawings upon request. Drawings will be made available at the discretion of the Engineer.

B. "Request Drawings" form can be accessed, filled out and submitted at http://www.klhengrs.com (right hand side of page - Contractor Resources). Direct access to this form can be found here: http://files.klhengrs.com/requestdrawings.html

1.8 QUALITY ASSURANCE

A. Contractor shall have a minimum five (5) years experience in the installation of systems similar to the systems specified. Contractor, if requested, shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor's inability to perform.

1.9 WARRANTY / GUARANTEE

A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner's option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Provide materials that are new, full weight, of the best quality. Obtain equipment, components and materials from single manufacturer for products of the same kind or category. Provide materials that are listed and labeled and marked for intended location and application.

B. Provide basis of design products or listed products equivalent in quality, performance, aesthetics, and product support (factory and local) to that specified as basis of design. Products not basis of design are subject to review by the Design Professional and possible rejection. Listing of a product manufacturer by name alone as an equivalent manufacturer shall not equate all products offered by that manufacturer to the basis of design.

C. Bear all costs incurred from deviation from basis-of-design materials, methods, labor, services, etc. Use of materials, methods, labor, services, etc. that deviate from the basis-of-design will be considered a statement that capacities, requirements, clearances, arrangements, performance, etc. have been checked, verified, found satisfactory, and align with intent of specified work and applicable codes and regulations.

D. Should deviation from basis of design equipment impact other contractors scope of work it shall be the responsibility of this contractor to coordinate with and cover these costs in addition to their own. This specifically includes electrical deviations from basis of design.

E. All manufacturer or contractor provided electrical disconnect switches shall comply with current National Electric Code requirements and rated to meet or exceed the overcurrent device serving the equipment.

F. Products shall not contain asbestos, lead, mercury, or mercury compounds and shall be suitable for piping service fluids, materials, working pressures, and working temperatures. Potable-water piping and components shall be deemed lead-free and comply with NSF 61 and NSF 14.

PART 3 - EXECUTION

3.1 GENERAL DIRECTION

A. Unless specifically indicated, provide all specified and drawn work as required to render all equipment and systems fully operational, including all ancillary, accessory, and support work. Install equipment and materials in strict accordance with manufacturer's written instructions.

B. In cases where products / materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.

C. Remove and replace items that impede new work installation including but not limited to fencing, doors, gypsum, lift-out panels, and structures to provide pathway for moving equipment into place.

D. Examine surfaces to receive products for suitable mounting conditions and verify compliance with installation tolerances and other conditions affecting performance of the work. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Equipment shall be installed in accordance with manufactures installation recommendations. Provide and maintain service, maintenance and operating clearances as required by the manufacturer.

3.2 SUPERVISION AND WORKMANSHIP

A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.

B. Contractor shall furnish the services of an experienced superintendent to be in constant charge of the work at all times. The superintendent's qualifications are subject to the review and acceptance by the Owner's Representative. Utilize the same plumbing superintendent throughout the duration of the project.

C. Provisions shall be made for owner’s representative or design professional to make rough-in and open ceiling inspections prior to covering up work.

D. Coordinate sizes and locations of concrete bases with architectural and structural elements. Concrete base shall be provided with all equipment provided.

E. Protect all piping, fixtures, and equipment exposed to physical damage.

F. Handling Flammable Liquids: Remove and dispose of liquids from existing gas piping according to requirements of authorities having jurisdiction.

3.3 PROJECT CONDITIONS

A. Do not interrupt existing utility service(s) to any facilitiy occupied by Owner or others until notification of no fewer than seven days in advance of proposed interruption of existing utility has been submitted to the Architect, Construction Manager, and/or Owner for approval. It is the contractor’s responsibility to obtain written permission from the Architect and/or Owner prior to any interruptions of service. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

3.4 CHANGE OF WORK

A. In the event of revised scope or work formally issued through Change of Work order, contractor shall provide an itemized breakdown of pricing and receive approval prior to commencing work.

3.5 ARCHITECTURAL COORDINATION ITEMS

A. Cutting and Patching:

1. Cut and drill all openings in roofs, walls, and floors required for the installation. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started. When drilling/cutting concrete slabs, utilize ground penetrating radar (GPR) and/or X-ray

scanning equipment to verify the location is free from obstructions, including but not limited to: structural rebar/strands/tendons, electrical conduit/wiring, and/or piping/ductwork.

B. Fire Caulking:

1. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
2. Provide products equivalent to the following:

   a. For Floor Openings: 3M; Fire Barrier Sealant CP 25WB+
   b. For Wall Openings: 3M; Fire Barrier Sealant CP 25WB+
   c. Mineral Felt: Rockwool; Firepro Firestop Compound
   d. For Insulated Pipes: 3M; Fire Sealant System CAJ5211
   e. For Fill Areas: 3M; Fire Barrier Packing Material PM 4

3. For larger openings where pipes penetrate fire rated enclosures that cannot be sealed with products described above, utilize approved UL products equal to 3M FireDam Spray 200.

C. Access Panels:

1. Provide all access panels required for proper servicing of equipment. Provide fire rated access panels at fire rated assembly penetrations rated at or above the fire rating of the assembly. Provide frame as required for finish. Coordinate installation with General Contractor as they may elect to install access panel. Exact location(s) must be approved by the Architect. Minimum size to be 12" x 12", units to be 16-gauge steel, primed for paint, and locking device shall be screwdriver cam locks.
2. For equipment above gypsum board or “hard ceilings”, provide equipment access panels sized to permit complete holistic removal of the unit in its entirety. Access panel shall also be sized to accommodate removal of the largest piece of equipment in the case where such access panel is used as a removal pathway for multiple pieces of equipment.

D. Piping Sleeves:

1. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction. Cut flush with both faces of wall. Floor sleeves shall extend one inch above floor top elevation. Roof penetrations shall be within a pipe curb assembly equal to Pate Co. Curb and flashing per roofing manufacturer’s requirements to maintain warranty.
2. Install rockwool and/or caulk between pipe and sleeve. Material must meet all applicable fire ratings.

E. Piping Escutcheon plates:

1. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.

F. Expansion Joints:

1. Provide flexible connectors where all pipes cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of piping.

3.6 PROTECTION OF SURFACES

A. Make every effort to protect roofs, walls and floors from foot traffic, equipment, carts, lifts, etc.

B. Make roof penetrations and install roof flashing in accordance with roofing manufacturer's recommendations. Obtain written certification from roofing manufacturer that work has been performed properly and that roof warranty is intact.

3.7 UTILITY VERIFICATION REQUIREMENTS

A. Field verify locations of underground and aboveground utilities, or those otherwise obscured from view, in the vicinity of work prior to commencing work. Utilize "811" call before you dig and hire locating service to identify, locate and mark remaining utilities and private lines.

B. Camera scope and dye testing existing piping, ductwork and pathways to confirm existing conditions and use including, but not limited to, voltage, natural gas pressure, sanitary, storm, chilled water, steam, etc.)

C. Obtain on-site approval from local utility prior to connecting to existing services.

D. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

3.8 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Receive, inspect, store and protect all materials required for new work. Do not accept or install any product damaged in any way.

B. Comply with all manufacturer guidelines and requirements for movement, storage, and protection of new work. All new work must be stored in a clean, dry place protected from weather and construction traffic. Maintain acceptable temperature and humidity per manufacturer recommendations. When stored inside or during transport through building, do not exceed structural capacity of the floor.

C. Coordinate and account for sizes of all new work included shipping materials with available openings. Account for rigging of all new work as required and as intended by manufacturer.

D. Do not install work until work area is sufficiently weathertight, all wet work in area is complete and all work above is complete.

E. Prior to installation, all products shall have the ability to be returned to the supplier or manufacturer after purchase and charged a reasonable restocking fee equal to a small portion of the cost.

F. Protect all new work through construction from damage. Take safeguards necessary to protect from damage. Items damaged during construction will not be accepted and shall be replaced with new.

G. Remove and replace all materials that have been installed improperly, physically damaged, moisture or water damaged, or mold damaged.

H. Fully remove all packaging materials inside and out prior to startup.

I. Retain all shipping protective covers and protective coatings during storage.

J. Fixtures and equipment being shipped and/or stored shall be covered with plastic sheeting and enclosed in a cardboard or wood crate.

K. Protect drains throughout all phases of construction to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

L. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.9 STARTUP, TESTING AND ADJUSTMENTS

A. Adjust fixtures, equipment, accessories, and moving parts to function smoothly and lubricate as recommended by manufacturer.

B. Provide necessary power to fixtures, equipment, and accessories to ensure proper functionality.

C. Complete installation and startup checks according to manufacturer's written instructions.

D. Perform the following adjustments before operation:

1. Check piping connections for tightness.
2. Close drain valves, hydrants, and hose bibbs.
3. Open shutoff valves to fully open position.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Adjust and set all temperature, pressure, and flow set points for all fixtures, equipment, and/or accessories as required by authorities having jurisdiction or manufacturers recommendations, whichever carries the highest importance.
6. Charge and test for leaks all plumbing systems, rectify all installation issues prior to putting any systems into service.

3.10 CLEANING EQUIPMENT AND PREMISES

A. Vacuum, clean and wipe down all new work and equipment inside and out. Exposed parts which are to be painted shall be cleaned of all foreign objects and prepped for paint.

B. During the progress of work, clean up and leave the premises and portions of the building in which work has occurred in a clean and safe condition. Provide this cleaning on a per-shift basis.

3.11 DEMONSTRATION / TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to product specific specification for training types and duration.

END OF SECTION 220501

SECTION 220503 - SUBMITTALS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and Division 22 Common Work Results for Plumbing Piping apply to this Section.

1.2 SUMMARY

A. Section Includes: Administrative, content and format requirements for preparation and submission of submittals.

B. Work of this Section is supplemental and additive to the requirements of Section 013300 where included in the Project Manual.

1.3 PRICE AND PAYMENT PROCEDURES

A. Payment in full or in part may be withheld from the Contractor for failure to comply with submittal requirements articulated in the Contract Documents.

1.4 SUBMITTALS

A. Submittals shall be furnished for each Section that includes one or more of the following elements of work:

1. Supply of one or more products.
2. Installation of one or more products.
3. Integration of one or more products.
4. Creation of one or more deliverable products.
5. Labeling of one or more products.
6. Contractor-based design or engineering of one or more products or systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Submittals shall be routed through established Project channels as identified by the Owner’s representative.

B. Coordinate, assemble, title, transmit and track Project submittals.

C. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall feature the same appearance and organization as those of other Sections.

D. Submittals prepared by subcontractors or vendors shall not be accepted unless prepared in compliance with the Contract Documents and this specification.

E. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections will vary and may include additional or lesser requirements.

F. Designer reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis. Additional submittals shall be provided at the Contractor's expense.

G. The cost for preparation and transportation of submittals is Work of the Contract.

H. Bind physical/hardcopy submittals together. Do not submit loose or paper clipped documents.

I. Supply separate submittals for each Specification Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents.

J. Where electronic submittals are required or permitted, comply with the requirements for electronic submittals as identified in the Contract Documents.

K. Organize submittals as identified in the Contract Documents.

L. Furnish submittals for different Specification Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Specification Section at a time. This allows for tracking and processing efficiency, so that:

1. Each Section may be reviewed simultaneously by different individuals, as appropriate.
2. Individual Sections may be processed and returned more quickly than others when some Sections require longer review times.
3. Submittals that are returned and marked as "Revise and Resubmit" do not cause submittals for other Sections to be also be resubmitted due to the fact that they were bound together as a single unit.

M. Availability of Electronic Drawings

1. Refer to Common Requirements specification section within this discipline for specifics in regards to obtaining electronic editable versions of drawings for the creation of shop and as-built drawings.

3.2 SUBMITTAL TYPES

A. The following are the common submittal types referenced in this Section:

1. Quality Assurance (QA).
2. Product Data (PD).
3. Shop Drawing (SD).
4. Training (TG).
5. Field Observation Response (FO).
6. Closeout Submittal (CO).

3.3 SUBMITTAL SEQUENCE

A. Quality Assurance Submittal:

1. When not expressly requested to be supplied with bid, the Quality Assurance submittal(s) shall be supplied upon request. When requested the submittal shall be delivered to the Designer within 16 business hours.

B. Product Data Submittal:

1. Submit following contract award or notice of intent to award a contract. Product data shall be submitted and reviewed prior to procurement of materials.

C. Shop Drawing Submittal:

1. Submit for review prior to commencement of fabrication and installation.
2. Submit concurrently with Section-specific Product Data submittals.

D. Training Submittal:

1. Submit thirty (30) days prior to the first training session.

E. Field Observation Report Submittal:

1. Submit five (5) business days prior to punch list walkthrough.

F. Closeout Submittal:

1. Submit following completion of onsite work but not more than ten (10) business days following successful Acceptance Testing.

3.4 SUBMITTAL IDENTIFICATION

A. Identify each submittal uniquely.

B. Identify each submittal by specification Section number, submittal type, and submittal iteration.

C. The format for labeling the submittals shall be as follows:

1. Section Number–Submittal Type Abbreviation–Submittal Iteration.
2. Examples:

a. First Product Data Submittal for section 224000: “224000-PD-00.”
b. Revised Product Data Submittal for section 224000: “224000-PD-01.”
c. Second Revised Product Data Submittal for 224000: “224000-PD-02.”

3.5 SUBMITTAL CONTENTS

A. All Submittals:

1. Transmittal:

   a. Supply a dedicated transmittal for submittals for each individual Section.
   b. Itemize the specific submittals included by Section, submittal type, and iteration.

2. Title Sheet:

   a. Include a separate title sheet with each submittal, of each type.
   b. Title sheets for each Section, for each submittal type, shall have the same appearance.
   c. Title sheets for product data submittals shall be 8-1/2 inches x 11 inches.
   d. Title sheets for drawings shall be the same size as the associated drawings.
   e. Create title sheets to have the appearance and information identified on the sample title sheet published at the end of this Section.

3. Index:

   a. Include an index outlining and identifying the contents of the submittal.
   b. The index for drawing submittals shall be incorporated onto the title sheet of the corresponding drawing set.

4. Checklists:

   a. Include the checklist(s) published in the Contract Documents corresponding to the type of submittal being supplied. Applicable checklists are found at the end of this Section and may also be found within individual Sections.

5. Title Blocks:

   a. Drawing submittals shall be created on the Contractor’s, manufacturer’s, or vendor’s own title block. The title blocks of the Owner, Architect, Engineer, Designer or their Consultants shall not be reproduced on any document (electronic or hardcopy) that is prepared or altered by the Contractor.

6. Legend:

   a. Drawing submittals shall include a legend of symbology.

7. Resubmittals:

   a. Resubmittals shall include a replica of the reviewer’s comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.

B. Quality Assurance Submittals:

1. List of Subcontractors to be used on the Project along with a description of the role each will play on the Project.
2. The last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value. References shall include:

    a. Owner's name and current contact information.
    b. Project address.
    c. Description of the system(s) and scope of actual work performed.
    d. Monetary contract value of the Work performed.

3. Financial Disclosure of the Contractor: Prior to contract award, upon request.
4. Product Datasheets Submittals:

    a. Separate manufacturer datasheets for each product.
    b. Datasheets shall be manufacturer originals or first generation printed versions (i.e., from PDF) of the manufacturer's official electronic datasheet:
        1) Distributor modified, distributor branded, and/or html based "web" datasheets are not acceptable.
        2) Datasheets shall include size and technical support data.

    c. Where manufacturer's datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or with bold visible arrows the model(s), version(s) and option(s) being supplied. Exact catalog number(s) shall be indicated.
    d. Each datasheet shall be labeled with the Section paragraph reference number. Datasheets shall include the Drawing reference when no specific paragraph reference exists within the Section.

C. Shop Drawing Submittals:

1. General:

    a. Drawing descriptions identify the required contents of common drawings required under the Contract.
    b. Drawings identified within individual Sections, along with any additional drawings deemed necessary by the Designer, are required.
    c. Drawing Scales:
        1) Floor plans shall be drawn to scale.
        2) Section drawings shall be drawn to scale.
        3) Elevation drawings shall be drawn to scale.
        4) Details of physical items shall be drawn to scale.

    d. Sizes:
        1) Sheet sizes shall match the size of the Contract Drawings sheets, except where otherwise expressly requested or approved in advance by the Designer.

D. Training Submittals:

1. Proposed schedule.
2. Training agendas for each session.

3. Identification of personnel that will conduct training.
4. Handouts proposed for distribution during training.

E. Field Observation Report Submittals:

1. Written responses to Field Observation Reports supplied to the Contractor during the course of the Project:

   a. The response shall include a copy of the original Field Observation Report.
   b. The response shall include detail of the corrective action taken, the date the action was taken and the identity of the individual who took the action.

F. Closeout Submittals:

1. As-Built Drawings:

   a. General:
      1) Requirements for Shop Drawings apply to “As-Built” drawings.

   b. Required Drawings:
      1) Title Sheet.
      2) Floor Plans.
      3) As-built version of each Project shop drawing.

   c. Drawing Formats:
      1) Electronic Editable: Editable version using the native application used to create the file (e.g., Revit, AutoCAD).
      2) Non-Editable: PDF file format.
      3) Printed Hardcopy.
      4) Sheets shall be the same size and feature consistent title block information in the lower-right corner.

   d. Drawing Organization:
      1) Hardcopy drawings shall be bound together into logical sets, bound along the left edge of the sheets.
      2) The first page of the set shall include a detailed index and sheet-by-sheet description of each drawing sheet.

2. Operation and Maintenance Manuals:

   a. Manual Format:
      1) Hard-cover 3-ring type binder.
      2) Front clear plastic cover pocket complete with Project and system Information insert.
      3) Clear plastic spine pocket with Project and system Information insert.
      4) Binder sized to suit the contents only, neither oversized nor undersized.
      5) Maximum binder thickness: 3 inches.

   b. Manual Contents and Organization:
      1) General:
         a) Separate binder (or binder set) for each system, labeled. Provide no more than one system per binder (or binder set).

b) Separate CD-ROM (or CD-ROM set) for each system, labeled. Provide no more than one system per CD-ROM (or CD-ROM set).
c) Do not overfill. Binders shall not be filled beyond an easily usable capacity.
d) Insert labeled tabs within binder to identify separate contents of the manual.
e) Labeled sub-directories shall be created on the CD-ROM to label and separate contents for the manual.

2) Project Information Cover:
   a) Title of Project.
   b) Name and address of Owner, Designer, Architect, Contractor of Record and Subcontractor.
   c) System name and specification references.
3) Index:
   a) Contents of the manual.
4) Warranty Statement:
   a) A warranty statement shall be included for each system. The warranty statement shall reiterate the terms of warranty identified within the Contract Documents, as well as identify how the Owner is to obtain warranty service.
   b) The warranty statement shall clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 2 year parts and labor).
   c) A separate warranty statement shall be supplied for each system.
   d) Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion.
   e) Supply standard out-of-warranty service rates and service contact information.
5) Bill of Materials:
   a) List of products supplied.
   b) Serial numbers of each product.
6) Product Datasheets (supply only in the electronic version of Operation and Maintenance Manual):
   a) Manufacturer datasheets for each product supplied.
7) Manufacturer Owner / User Manuals:
   a) Manufacturer's Owner's or User's manual for each product.
   b) Manufacturer's Installation instructions and other documentation supplied with the product.
8) Test Reports and Checklists:
   a) Test reports, checklists, and other forms generated and completed during the course of the Project.
9) As-Built Drawings:
   a) The hardcopy manual shall contain reduced scale printed version (11x17) of system-specific drawings.
   b) The electronic manual shall contain electronic PDF version of the as-built drawings.

3.6 SUBMITTAL QUANTITY

A. General:

1. The quantity of submittals required shall be the greater of the following:

    a. Quantity identified within Division 01.
    b. Quantity identified within the individual Section.
    c. Quantity identified herein.

2. In addition to the Contract required quantity, the Contractor shall also submit any additional quantities required for its own use and records, and for distribution to other trades.
3. The Designer shall retain a copy of each submittal received. Others in the submittal communication chain may also retain copies.

B. Product Data Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

C. Shop Drawings Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

D. Field Observation Report Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

E. Samples Submittals:

1. Two (2) Hardcopies.
2. One (1) Electronic.

3.7 SUBMITTAL REJECTION

A. The following items are representative reasons that submittals may need to be revised and resubmitted:

1. Binding submittals for multiple Sections together.
2. Failing to supply separate transmittal for submittals for each Section.
3. Failing to include a submittal title sheet.
4. Failing to use and accurately complete the published title sheet.
5. Failing to supply and accurately complete the submittal checklists.
6. Failing to supply product data and shop drawings at the same time.
7. Failing to supply product data sheets.
8. Failing to supply product data sheets with the correct product and required accessories enumerated.
9. Failing to supply shop drawings.
10. Failing to supply shop drawings with required information.
11. Failing to supply accurate information.
12. Failing to supply relevant information required by the Specifications.
13. Failing to supply products that are in compliance with the Specifications.

14. Failing to supply the required information in the required format.

3.8 RESUBMITTALS

A. Revise and Resubmit:

1. When a submittal is rejected and flagged as “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality.
2. Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon.

B. Exceptions Noted:

1. When a submittal is flagged as “Exceptions Noted,” the specific actions identified shall be taken.
2. If the reviewer’s comments include selective rejection of products, the resubmittal shall be limited to include those items commented upon.

C. Resubmittals shall:

1. Include a copy of the reviewer’s previous comments.
2. Include a written description of the action(s) taken.
3. Be labeled chronologically.
4. Be inclusive of all corrective action identified by the previous reviewer.

3.9 ELECTRONIC SUBMITTALS

A. Electronic submittals shall only be permissible where electronic submittals are expressly required and where express approval for such has been granted.

B. Electronic submittal files shall be compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard, version 1.5.

C. Major text within the files shall be electronically searchable using the search-for-text features of current generation Adobe PDF reader software. Files shall be prepared in such manner that reviewers will have the option to search for and find words and phrases that appear within the document, electronically. Documents featuring raster-based text and text that is otherwise not searchable shall not be acceptable. This precludes the use of documents that have been electronically scanned and then converted to or embedded within an electronic file.

D. The organization, contents, and labeling of information along with other requirements for submittals apply also to electronic versions of the submittals.

E. Single File Submission:

1. Option 1 – Single File, PDF Format:

a. Single PDF file submittals shall be assembled from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked to aid the reviewer in navigating the content.
b. The file shall feature a navigational tree of contents, organized by content groups (e.g., Title Page, Index, Datasheets, Shop Drawings). Content groups shall be organized in the same relative order identified within the Contract Documents.
c. Within each content group shall be the supporting elements of the group (e.g., product datasheets under the Datasheets group). Each element of the content group shall appear separately as a subordinate element of the group (e.g., separate entry for each product datasheet, separate entry for each shop drawing), and viewable from the navigational contents tree.
d. Under the Datasheets content group, individual product datasheet entries shall be identified by Make/Brand and Model. Entries shall be organized in a sorted manner, first by make, then by model.
e. If the resulting size of the composite PDF file exceeds 10 Megabytes, supply the submittal using the Single Zip File method instead, as described in this Section.
f. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., 224000-PD-01.pdf).
    1) Where the Designer directs the supply of multiple zip files for a submittal, add additional text to the file name to identify that the file is part of a multi-file set of submittals, as per the following examples:
        a) 224000-PD-01 (1 of 3).pdf
        b) 224000-PD-01 (2 of 3).pdf
        c) 224000-PD-01 (3 of 3).pdf

2. Option 2 – Single File, Zip Format:

a. Single Zip File submittals shall be assembled from a series of individual PDF files and file directories that are contained with a single compressed WinZip compatible ".zip" file.
b. The file shall contain separate top-level directories that are used to group related content (e.g., 00-Title Page, 01-Index, 03-Datasheets, 04-Shop Drawings), with each directory appearing in the same relative order as that identified in the Contract Documents.
c. Within each content group directory shall be separate PDF-compliant files featuring the information required (e.g., separate datasheet file for each product, separate file for each drawing).
d. Product datasheet files shall be named using a consistent naming convention that enables those files to appear sorted and grouped when the file is opened for navigation, viewing or extraction by the reviewer.
e. Product datasheet files shall be consistently named with the make/brand of the product, followed by model number, followed by any additional information beneficial.
f. Consult the Designer for supplement instructions should the WinZip file exceed 50 Megabytes in size.
g. The file name used for the submittal shall be the Section number followed by the submittal instance number for that Section (e.g., 224000-PD-01.zip).
    1) Where the Designer directs the supply of multiple zip files for a submittal, add text to the file name that identifies the file is part of a multi-file set as per the following examples:

a) 224000-PD-01 (1 of 3).zip
b) 224000-PD-01 (2 of 3).zip
c) 224000-PD-01 (3 of 3).zip

END OF SECTION 220503

SUBMITTAL TITLE SHEET
EXAMPLE
(Form: Sub-1)

PROJECT TITLE:

Project Name Line 1
Project Name Line 2
Project Name Line 2

SUBMITTAL TYPE:

Product Data

SECTION SUBMITTAL NUMBER

224000.00-PD-00

SECTION TITLE:

Plumbing Fixtures

Date Prepared:

yyyy-mm-dd

CONTRACTOR OF RECORD:

Firm Name
Address1
Address 2
City, State, Zip
Phone (000) 000-0000, Fax (000) 000-0000
Project Manager: Full Name
PM E-Mail: xxxxxxxx@xxxx.xxx

SECTION SUBCONTRACTOR(S):

Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxxx@xxxx.xx	Firm Name Address 1 Address 2 City, State Zip Phone (000) 000-0000 Fax (000) 000-0000 PM Name: Full Name PM E-Mail: xxxxxxxxx@xxxx.xx

PRODUCT DATA SUBMITTAL
CHECKLIST
(Form: Sub-2)

Each line below featuring text shall be supplied with an answer.

	No	Yes
Transmittal		
Title Sheet		
Project Name		
Specification Section number		
Submittal iteration number *(0 for first iteration, 1 + for each subsequent iteration (e.g., 224000-0, 224000-1))*		
Contractor of Record identified		
Sub-contractor / vendor / supplier name identified		
Title Sheet appearance consistent with sample title sheet		
Checklists included		
This checklist		
Checklists from Section being submitted (where applicable)		
Previous submittal review, with contractor actions and comments		
Product Datasheets included		
Datasheets are manufacturer originals		
Datasheets for each product included		
Section paragraph and/or Drawing reference on each datasheet		
Product accessories and options identified		
Products organized by paragraph (or alphabetically by brand)		
No photocopies, faxes and other illegible datasheets included		
Shop Drawings included		
Shop drawings accompany this product data submittal.		
This submittal contains product data for one Section only.		

This checklist serves as a simple and abbreviated reminder of the contents and format of the aforementioned submittal. Refer to Section 220503 "Submittals for Plumbing" and each specific Section for additional submittal requirements. Submittals are subject to rejection if this checklist is not accurately completed and provided along with the specified information. Reproduce this checklist and submit with each submittal for each Section.

SECTION 220505 - EXISTING CONDITIONS AND DEMOLITION

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 DESCRIPTION OF WORK

A. Prior to submitting a bid, the Plumbing Contractor shall perform a detailed walk-through field inspection, to review the existing structures and premises, to determine all existing conditions, equipment/ piping locations, etc. and shall make all necessary allowances for all required Plumbing related demolition and relocation work. This pre-bid inspection by the Plumbing Contractor shall include inspection of all applicable accessible ceiling cavity, areas, etc.

B. Should the Plumbing Contractor take any exceptions to providing any related demolition or relocation work, such exceptions shall be stated in detail within the Prime Contractor's bid. No subsequent allowance to the contract cost shall be made for any insufficient allowances made by the Plumbing Contractor during bidding which may result from the Plumbing Contractor's failure to visit job site and review drawings.

C. Demolition related work may not be specifically indicated on drawings, but shall be included under base bid. All Plumbing related demolition, relocation, etc. work, including work described herein, shall be under base bid.

D. It is not the intent of these contract documents that existing conditions be accurately shown. Existing Plumbing work is shown to a limited extent on drawings and is shown for general planning reference only. Such locations, etc. have been located from portions of contract documents which were prepared for previously installed work (not from "as-builts"). These locations are not guaranteed. The successful Plumbing Contractor shall have access to all available existing building/system plans and specifications.

E. The existing plumbing systems may be utilized only to the extent indicated herein or on drawings and/or as directed by Owner's representative in field.

F. Routing of all new plumbing systems in existing buildings shall be approved by Owner's representative prior to installation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EFFECT ON ADJACENT OCCUPIED AREAS

A. Locate, identify, and protect existing Plumbing services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. It is recognized that there may be some systems rendered inactive by demolition, causing disconnection of "downstream" branches, equipment, etc. which serve occupied areas. It shall be the responsibility of the Plumbing Contractor to investigate these types of conditions (for all systems) prior to demolition. Provide all necessary corrective Plumbing work prior to demolition to ensure that such "downstream" work remain permanently active throughout demolition, new construction and after project completion.

C. All work and system shutdowns shall be carefully coordinated in advance with owner's representative and all affected trades so that normal building activities and other construction trades are minimally affected. All required Plumbing related demolition and/or new construction work, which will affect any and all occupied areas (including those which are located outside the immediate area of project work) shall be performed at special times if/as directed by Owner's representative in field.

D. All existing systems and components shall remain fully operational in all occupied spaces during all occupied periods.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and/or other system components. During cutting and patching operations, protect adjacent installations. Remove protection and barriers after demolition operations are complete.

3.2 WORK IN EXISTING SPACES

A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.

B. Existing Ceilings: Where work is being performed above ceilings, and the architectural drawings do not indicate ceiling modifications by the General Contractor, it shall be the responsibility of this contractor to remove and replace existing ceilings where work is being performed. In those instances, all repair and installation of new grid, ceiling panels, etc shall be the responsibility of this contractor. Match existing finishes.

C. Walls & Floors: It shall be the responsibility of this contractor to patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.

D. If asbestos, PCB's, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

3.3 GENERAL DEMOLITION

A. Provide complete Plumbing demolition as required for all systems throughout all project areas not indicated to be salvaged or saved. Unless specifically noted otherwise on plans or determined otherwise during this contractor's pre-demolition survey, all abandoned existing Plumbing work in the project areas shall be disconnected and removed in its entirety by the Plumbing Contractor. All related work shall comply with the notes specified herein.

B. Provide demolition work as required to clear and remove all existing Plumbing work to be abandoned and as required to accommodate all new work of all trades. In general, remove existing related piping, control media, etc. back to nearest concealed accessible terminal or take-off "upstream". Extend piping, etc. as required to accommodate new or relocated Plumbing work.

C. Remove abandoned, inactive and obsolete equipment, piping, etc. Abandoned work embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove all abandoned materials above accessible ceilings.

D. Perform cutting and patching required for demolition in accordance with the contract documents.

E. All abandoned and piping shall be removed and capped back to respective sources, even if sources are outside of the confines of the project area. Coordinate all work carefully with Owner prior to beginning any Plumbing demolition work.

F. All piping, etc. conflicting with construction related work of any and all trades shall be removed and/or relocated by the Plumbing Contractor as necessary and/or as directed by Owner's representative in the field. Plumbing disconnections (and/or reconnections) for equipment to be removed (and/or relocated) shall be by the Plumbing Contractor. This shall apply to all existing Plumbing work whether shown on drawings or not.

G. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

H. Provide new work as required to accommodate relocations, etc. Routing of all new and piping in existing buildings shall be held tight to structure above wherever possible and shall be approved by owner's representative prior to installation.

3.4 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

A. Except where specifically noted otherwise herein or on drawings, all Plumbing work shown on new work plans shall be new.

B. If required to accommodate construction related activities, remove and reinstall any conflicting fixtures, devices or equipment that are to remain.

C. All abandoned materials removed during demolition and thereafter shall be referred to the Owner's representative for disposal instructions. All materials which the Owner elects to retain shall be neatly stored at the site by the Plumbing Contractor as designated by the Owner's representative. All materials which the Owner elects not to retain shall be disposed of by the Plumbing Contractor in a lawful manner.

D. All fixtures, devices or equipment designated for salvage (removal and reuse, or for turning over to Owner) shall be disconnected and removed undamaged. Disconnect all pigtails, etc. from equipment terminal points and carefully transport and neatly store same to a protected on-site storage location as directed in field.

E. Components to be reused shall be cleaned (inside and out) and reinstalled where indicated on drawings. Modify and/or extend related existing ductwork and/or piping as required.

F. Components turned over to Owner shall be neatly stored as groups by system type.

3.5 PRE-EXISTING CODE VIOLATIONS

A. All existing work which is accessed and/or used under this project shall be inspected and brought into compliance with current codes and standards by the Plumbing Contractor. This shall apply only to the extent that such work is uncovered in the immediate project areas affected by demolition and/or new construction and only to the limited extent that it applies to pre-existing general installation methods (i.e. a missing hanger/support, a missing seal and other minor incidental work.

B. If more extensive code or safety violations are discovered by the Plumbing Contractor, they shall be immediately brought to the attention (detailed in writing) of the Owner's representative along with the contractors proposed cost for corrections.

3.6 INTERIM LIFE SAFETY WORK

A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

END OF SECTION 220505

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Product Data:

1. Provide product datasheets for all products specified under this section.
2. Include construction details, material descriptions, dimensions of individual components, finishes, rated capacities, operating characteristics, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION FITTINGS

A. Metal-Bellows Packless Expansion Fittings:

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. Adsco Manufacturing LLC.
   b. Hyspan Precision Products, Inc.
   c. Metraflex, Inc.
   d. U.S. Bellows, Inc.
   e. FlexiCraft Industries.

   Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
2. Sanitary metal expansion joints shall consist of a single hydraulically formed metal bellows with an integral, smooth bore silicone liner and flange end fittings with integral tie rods.
3. Flanges and tie rods shall be 304 stainless steel and ANSI B16.5 150# type.
4. Type: Circular, corrugated bellows with external tie rods.
5. Potable water piping and components shall comply with NSF 14 and NSF 61.
6. Minimum Pressure Rating: 150 psig unless otherwise indicated.
7. Expansion Fittings for Copper Tubing: Single-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
   c. End Connections for Copper Tubing Larger than NPS 4: Flanged.

B. Flexible-Hose Packless Expansion Fittings:

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. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Metraflex, Inc.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Potable water piping and components shall comply with NSF 14 and NSF 61.
4. Sanitary flexible expansion joints shall comply with IAPMO IGC 304.
5. Elbows: 304 Stainless Steel long radius 90º elbows.
6. Flexible Hose: 321 Stainless Steel hose, 304 Stainless Steel braid and interlocking liner.
7. Brass cleanout plugs (2).
8. +- 8” of movement.
9. 150 PSI working pressure at 70ºF.
10. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
11. 304 Stainless Steel long radius 90º elbows.
12. Expansion Fittings for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

    a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

13. Expansion Fittings for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

14. Expansion Fittings for Steel Piping NPS 2 and Smaller: Stainless-steel fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.

15. Expansion Fittings for Steel Piping NPS 2-1/2 to NPS 6: Stainless-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

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. Adsco Manufacturing LLC.
    b. Flex-Hose Co., Inc.
    c. Hyspan Precision Products, Inc.
    d. Metraflex, Inc.
    e. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION FITTING INSTALLATION

A. Install mechanical expansion fittings at a minimum of every 100 feet on straight runs of all piping and where specifically indicated on drawings.

B. Install flexible hose mechanical expansion fittings and/or expansion loops in any piping crossing a building expansion joint whether indicated on the mechanical drawings or not. Coordinate these locations with the Architectural and Structural drawings.

C. Install expansion fittings of sizes matching sizes of piping in which they are installed.

D. Install metal-bellows expansion fittings according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion fitting not more than four pipe diameters from expansion joint.

C. Install second guide(s) at 10 to 14 pipe diameters from first guide. Install intermediate guides spaced at the following distances for the indicated pipe size:

1. 1 inch pipe: 11 feet
2. 1-1/4 inch pipe: 14 feet
3. 1-1/2 inch pipe: 17 feet
4. 2 inch pipe: 23 feet
5. 2-1/2 inch pipe: 27 feet
6. 3 inch pipe: 33 feet
7. 4 inch pipe: 40 feet

D. Attach guides to pipe and secure guides to building structure.

E. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

F. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

G. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

H. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

SECTION 220517 - SLEEVES AND SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Product Data:

1. Provide product datasheets for all products specified under this section.
2. Clearly state full load amps (FLA), voltages and model numbers on all submittals.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Install steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.
6. Link-Seal Modular Seals

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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. Presealed Systems.
2. Advance Products & Systems, Inc.
3. CALPICO, Inc.
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.
6. Proco Products, Inc.
7. Link-Seal Modular Seals

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

B. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

C. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

E. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

F. Using grout, seal the space around outside of stack-sleeve fittings.

G. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

    a. Cast-iron wall sleeves with sleeve-seal system.
        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Cast-iron wall sleeves with sleeve-seal system.
        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Stack-sleeve fittings
    b. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

5. Interior Partitions:

a. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Product Data:

1. Provide product datasheets for all products specified under this section.
2. Clearly state model numbers on all submittals.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. Hinged or Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

C. Manufacturer's: Subject to compliance with requirements available manufacturer's offering products that may be incorporated into the work include, but limited to the following:

1. AWI
2. Brass Craft
3. Mcguire Manufacturing Co., inc.
4. Watts
5. Pro-Flo

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Provide escutcheons with ID to closely fit around pipe, tube, and/or insulated piping and with OD that completely covers rough penetration opening of walls, ceilings, floors, casework, surrounds, and countertops in finished spaces.

1. Escutcheons for

a. New piping with fitting or sleeve protruding from wall: One-piece, deep-pattern type.
b. New bare and/or insulate piping at wall, floor, and ceiling penetrations in finished spaces: Hinged or split-cast, shallow-pattern type.
c. Fixtures and valve bodies in finished spaces.

3.2 FIELD QUALITY CONTROL

A. Replace broken, damaged, and/or missing escutcheons using new materials.

END OF SECTION 220518

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, material descriptions, and finishes.
2. Clearly state model numbers on all submittals.

1.2 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

PART 2 - PRODUCTS

2.1 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Watts Regulator Co.

2. Description:

   a. Standard: MSS SP-110.
   b. CWP Rating: 600 psig.
   c. Body Design: Two piece.
   d. Body Material: Bronze, lead-free dezincification-resistant.
   e. Seats: PTFE or TFE.
   f. Stem: Bronze, blowout-proof.
   g. Ball: Chrome-plated brass.
   h. Port: Full.
   i. Adjustable packing gland.
   j. Vinyl-covered steel handle.

B. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. m

2. Description:

   a. Standard: MSS SP-110.
   b. CWP Rating: 600 psig.
   c. Body Design: Three piece.
   d. Body Material: Bronze, lead-free dezincification-resistant.
   e. Ends: Threaded.
   f. Seats: PTFE or TFE.
   g. Stem: Bronze, blowout-proof.
   h. Ball: Chrome-plated brass.
   i. Port: Full.
   j. Adjustable packing gland.
   k. Vinyl-covered steel handle.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Set ball and plug valves open to minimize exposure of functional surfaces.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 DOMESTIC WATER VALVE SCHEDULE

A. Isolation/Control Valves

1. All valves installed in domestic water piping 3” and smaller shall be ball valves.

    a. Ball Valves - 1 Inch and Smaller: 2-piece body. Provide extended valve stems for valves used on insulated lines. Provide equal to Nibco Series 585-80-LF.
    b. Ball Valves – 1-1/4 Inch and Larger: 3-piece body. Provide extended valve stems for valves used on insulated lines. Provide equal to Nibco Series 595-Y-LF.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTAL REQUIRMENTS

A. Product Data: For each type of product.

1. Include construction details, rated capacities, material descriptions, dimensions of individual components and profiles, and finishes.
2. Clearly state model numbers on all submittals.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon or stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.
3. For vertical piping NPS 2 and smaller: Van (Bell) hangers; Carbon steel, copper plated with epoxy coating and stainless steel screw. Size to match pipe size.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anvil International, Inc.
2. Elcen Metal Products Co.
3. PHD Manufacturing, Inc
4. National Pipe Hanger Corp.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ERICO International Corporation.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
3. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head
c. MKT Fastening, LLC

d. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc
b. ITW Ramset/Red Head
c. MKT Fastening, LLC
d. Powers Fasteners

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

B. Do not suspend hangers from roof decks. Suspend from roof trusses, joists and joist girders only at panel points and at top chords unless otherwise indicated.

C. All piping hangers in exterior spaces, such as parking garages, exposure to high humidity, etc., or in interior swimming pool areas shall be galvanized.

D. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

E. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

G. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.

H. Use padded hangers for piping that is subject to scratching.

I. All plumbing equipment shall have concrete bases and/or structural steel supports and shall be provided by this contractor.

J. The use of pumps or other equipment as piping supports shall be prohibited. All such connectors and their supports shall be independently supported from the building structure and inspected and approved by the Engineer before bolting.

K. Piping connections to all equipment with moving parts shall be isolated with braided copper or stainless steel flexible links, which shall be selected to absorb the deflection on the isolating members.

L. Use thermal-hanger shield inserts for insulated piping and tubing.

M. Hanger and support types:

1. Hangers: Provide adjustable, Steel Clevis Hangers (MSS Type 1) for suspension of noninsulated or insulated, stationary pipes.
2. Horizontal-Piping Clamps: Provide Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3) for suspension of pipes requiring clamp flexibility and up to 4 inches of insulation.
3. Vertical-Piping Clamps: Provide extension pipe or Riser Clamps (MSS Type 8) for support of pipe risers.

N. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

O. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Inserts:

   a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from structural concrete ceiling.

2. Clamps:

   a. C-Clamps (MSS Type 23): For structural shapes.
   b. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

3. Miscellaneous:

   a. Welded Beam Attachments (MSS Type 22): For attaching to bottom of steel beams if loads are considerable and rod sizes are large.
   b. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      1) Light (MSS Type 31): 750 lb.
      2) Medium (MSS Type 32): 1500 lb.
      3) Heavy (MSS Type 33): 3000 lb.

   c. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   d. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

P. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

Q. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

T. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

U. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

V. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

W. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

X. Install lateral bracing with pipe hangers and supports to prevent swaying.

Y. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, expansion joints, strainers and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

Z. Provide pipe rollers for hot water mains. Provide pipe rollers approved equal to Anvil Fig. 171, 175, 177, 181 and 271.

AA. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

BB. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

CC. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation. Do not exceed pipe stresses allowed by manufacturer.
   b. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   c. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   d. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shields:

    a. Install protective galvanized steel shields, MSS Type 40, on insulated piping smaller than 2-inch NPS. Shields shall span an arc of 180 degrees and shall be a minimum of 12-inches in length.
    b. Install thermal-hanger shield inserts on all insulated piping 2-inch NPS and larger.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
6. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
7. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
8. Vertical Piping: MSS Type 8 or Type 42, clamps.
9. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

10. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
11. Base of Vertical Piping: MSS Type 52, spring hangers.

DD. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

EE. Support vertical piping and tubing at base and at each floor.

FF. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

GG. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 4: 10 feet with 1/2-inch rod.

HH. Install supports for vertical copper tubing every 10 feet.

II. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" or Section 099600 "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Piping:

Piping Material	Pipe Size	Hanger Spacing (OC)	Vertical Support (OC)
Cast Iron	Any	5’-0”	15’-0”
Ductile Iron	Any	5’-0”	15’-0”
Copper	1-1/4” and smaller	6’-0”	10’-0”
Copper	1-1/2” and larger	10’-0”	10’-0”
PVC	Any	4’-0”	10’-0”
CPVC	1” and smaller	3’-0”	10’-0”
CPVC	1-1/4” and larger	4’-0”	10’-0”
Polyethylene Piping (PE)	Any	2’-6”	10’-0”
Steel	Any	12’-0”	15’-0”

1. In addition to supported pipe information above, support piping at each change in direction.

B. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

C. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data: For each type of product.

1. Provide product datasheets for all labels, signs, valve tags, and warning tags.

B. Closeout Submittals (CO):

1. Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

E. Pipe Label Color Schedule:

1. Domestic Cold Water, Hot Water, Hot Water Return and Sanitary Piping:

a. Background Color: Green.
b. Letter Color: White.

2. Fuel Gas Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved 1-1/2 inch diameter brass with 1/4-inch stamped letters for piping-system abbreviation and 1/4-inch alphanumeric lettering.

1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass beaded chain.
3. Associated piping system.
4. Location of valve (architectural room name and/or number).
5. Normal-operating position (open, closed, or modulating).
6. Identify special or unique characteristics (emergency shutoff).

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Locate equipment labels where accessible and visible. Install or permanently fasten labels on each major item of mechanical equipment. Install identifying devices with completion of

covering and painting of surfaces where devices are to be applied, locations of access panels and doors, and acoustical ceilings or similar concealment.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION 220553

SECTION 220719 - PLUMBING SYSTEMS INSULATION

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data:

1. Provide product datasheets for all insulation materials, adhesives, and sealants. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.2 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

C. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Pittsburgh Corning Corporation; Foamglas.
   b. Owens-Corning Fiberglass Corp.
   c. Knauf
   d. CertainTeed.
   e. Johns Manville.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS. ASTM C 534, Type I

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fibrex Insulation, Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation, Inc.; Alley-K.
e. Owens Corning; Fiberglass Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

F. Fiberglass Insulation:

1. Fiberglass piping insulation: ASTM C 547, Type 1 and 4
2. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers.
3. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing.
4. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
5. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
6. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

a. Armstrong World Industries, Inc.
b. Owens-Corning Fiberglass Corp.
c. Keene Corp.
d. CertainTeed.
e. Johns Manville.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with 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. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with 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."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with 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."

2.3 SEALANTS

A. Joint Sealants:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

    a. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.6 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M; 0.015 inch thick, 1/2 inch wide.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inchnickel-copper alloy.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

    a. Engineered Brass Company.
    b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.

c. McGuire Manufacturing.
d. Plumberex.
e. Truebro.
f. Zurn Industries, LLC.

2. Description: Manufactured plastic wraps for covering plumbing fixture water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

a. Truebro; a brand of IPS Corporation.
b. Zurn Industries, LLC.
c. ProFlo
d. Plumberex.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
2. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
3. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
4. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
5. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
6. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
7. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
8. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
9. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD QUALITY CONTROL

A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces, unless piping is subject to freezing.
2. Underground piping conveying unheated fluids.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. Insulation shall be one of the following:

   a. Fiberglass: 1 inch thick.
   b. Flexible Elastomeric: 1/2 inch thick.
   c. Insulation thicknesses shall be doubled for piping installed in non-conditioned spaces such as boiler rooms, attics, crawl spaces, tunnels, etc.

B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. One-piece PVC, with 1/8” thickness, meeting the standards of ASTM E 84-07 with a flame spread/ 450 smoke index per the building code. Surfaces to be soft, smooth, non-absorbent, easy to clean U/V inhibited, antimicrobial, antifungal properties. Insulator shall have a dual fastening system which consists of fusion bonded Velcro fastener strips for full slit enclosure and tamper resistant, smooth, non-abrasive snap-locking fasteners. P-Trap Insulator: Shall have a one-piece design with a universal fit for 1 1/4"-1 1/2" brass or plastic traps, a longer neck area (for longer tailpieces) and a more forgiving girth area (for bulkier plastic DWV Schedule #40 plastic P-Traps w/swivel nut) and shall have drainage at lowest point to prevent condensation and/or leakage build up. Valve and Supply Insulator: Shall have a one-piece design with a universal fit over valve handles and brass, plastic or metal braided supplies and connectors and shall be able to flexcurl to a minimum of 360 degrees with a full slit closure for total compliance. Off-Set Insulator: Shall have a one-piece design with a universal fit and shall fit inside of P-trap insulator tailpiece area.
   b. Soft, resilient molded vinyl, with 1/8” minimum constant nominal wall thickness with internal ribs, UV resistant, which meets the requirements of ASTM D-635 burning characteristics.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data (PD):

1. Provide product datasheets for all products specified under this section.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 COPPER TUBE AND FITTINGS; PIPE SIZE LESS THAN 3”

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

F. Copper Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

   a. Elkhart Products Corporation.
   b. NIBCO Inc.
   c. Viega.

2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

G. Copper-Tube, Extruded-Tee Connections:

1. Extruded-Tee Connections shall be permitted where new mains are connected to existing mains only: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Piping Specialties Products.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Charlotte Pipe and Foundry Company.
   b. Harvel Plastics, Inc.
   c. Spears Manufacturing Company.

2. Description:

   a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
   b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Colonial Engineering, Inc.
   b. NIBCO Inc.
   c. Spears Manufacturing Company.

2. Description:

   a. CPVC four-part union.
   b. Brass or stainless-steel threaded end.
   c. Solvent-cement-joint or threaded plastic end.
   d. Rubber O-ring.
   e. Union nut.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International.
   e. Matco-Norca.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Standard: ASSE 1079.

3. Pressure Rating: 125 psig minimum at 180 deg F
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Matco-Norca.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing above building slab according to CDA's "Copper Tube Handbook."

C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

A. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

B. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples, or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 5 feet with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 6 feet with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 9 feet with 1/2-inch rod.
5. NPS 3 to NPS 4: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2and larger.

3.7 FIELD CONDITIONS

A. Where new domestic water systems are required to be connected to existing domestic water systems, it is the contractor's responsibility to verify the location, size, pressure, condition, and they shall verify that the existing domestic water system is indeed a domestic water system before any work is done. Provide all necessary tools, materials and labor for testing as necessary. If there is any need for concern, if it is determined that the existing domestic water system is not a domestic water system or not connected to a domestic water system, if the condition of the existing domestic water system is not viable for re-use, or any other condition that would not allow the proper functioning of the new domestic water system, the contractor shall notify the engineer in writing immediately via RFI and wait for direction before proceeding.

B. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Architect's written permission.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 4 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 3 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 4 and larger.
3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

1. Provide product datasheets for all products specified under this section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2.2 PIPING MATERIALS

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class. All cast iron soil pipe and fittings shall be certified NSF and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888, ASTM A 74, or CISPI 301. Fittings shall be cast iron conforming to ASME B16.4, ASME B16.12, ASTM A 74, ASTM A 888 or CISPI 301. All cast iron soil pipe and fittings shall be certified NSF and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

B. Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Fernco Inc.
c. MIFAB, inc.

2. Standards: ASTM C 1277 or CISPI 310. All couplings shall be certified NSF and certified to be tested according to ASTM C 1563..
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Charlotte Pipe and Foundry Corporation.
2. North American Pipe Corporation.
3. Spears Manufacturing Company.

B. Solid-Wall, Schedule 40 PVC Pipe: ASTM D 2665 and ASTM D 1784 drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 2665, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Shielded, Nonpressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) ANACO-Husky.
      2) Fernco Inc.
      3) MIFAB, inc.

   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Spears Manufacturing Company.
      2) Watts Water Technologies, Inc.
      3) Zurn Industries, LLC.

   b. Description:
      1) Standard: ASSE 1079.
      2) Pressure Rating: 125 psig minimum at 180 deg F.
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Spears Manufacturing Company.
      2) Watts Water Technologies, Inc.
      3) Zurn Industries, LLC.

   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Advance Products & Systems, Inc.
      2) Calpico, Inc.
      3) Central Plastics Company.

b. Description:
   1) Nonconducting materials for field assembly of companion flanges.
   2) Pressure Rating: 150 psig.
   3) Gasket: Neoprene or phenolic.
   4) Bolt Sleeves: Phenolic or polyethylene.
   5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Grinnell Mechanical Products.
      2) Matco-Norca, Inc.
      3) Precision Plumbing Products, Inc.

   b. Description:
      1) Standard: IAPMO PS 66
      2) Electroplated steel nipple.
      3) Pressure Rating: 300 psig at 225 deg F.
      4) End Connections: Male threaded or grooved.
      5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

A. Where new sanitary sewers are required to be connected to existing sewers, it is the contractor's responsibility to verify the location, size, invert elevation, condition, and they shall verify that the existing sewer is indeed a sanitary sewer before any work is done. Provide all necessary camera scoping and dye testing as necessary. If there is any need for concern, if it is determined that the existing sewer is not a sanitary sewer or not connected to a sanitary sewer, if the condition of the existing sewer is not viable for re-use, or any other condition that would not allow the proper functioning of the new sewer, the contractor shall notify the engineer in writing immediately via RFI and wait for direction before proceeding.

B. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

   1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Slope piping according to local codes.

F. Install piping free of sags and bends.

G. Install piping to allow application of insulation.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Collect vent piping where practical so roof will be penetrated a minimum number of times. Vent sizes and heights above roof shall be per the Plumbing Code in force. Vents penetrating roofs shall be flashed with 4 lb. sheet lead. Vents shall not be terminated within ten feet of any outside air intakes, windows, or door openings.

K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

M. Install aboveground PVC piping according to ASTM D 2665.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. PVC piping shall not be installed in plenum spaces.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

1. Cast iron coupling for joining hubless cast iron pipe shall consist of neoprene gasket produced and labeled as ASTM C 564, cast iron clamps produced and labeled as ASTM A 48 and stainless steel bolts and nuts produced and labeled as ANSI B18.2.1 and ANSI B18.2.2. Neoprene gaskets shall be produced and labeled as ASTM C 564-70.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Solvent cements shall conform to ASTM D 2665.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.
3. Primers conforming to ASTM F 656 shall be applied to all joint surfaces.
4. Solvent cement conforming to ASTM D 2564 shall be applied to all joint surfaces. The joint shall be made while the cement is wet and shall be in accordance with ASTM D 2855.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.

3.5 CONNECTIONS

A. Use transition fitting to join dissimilar piping materials.

B. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

D. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.7 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.8 PIPING SCHEDULE

A. Aboveground, soil and waste piping shall be any of the following:

1. Solid-wall, Schedule 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

B. Aboveground, vent piping shall be any of the following:

1. Solid-wall, Schedule 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221613 - NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data:

1. Provide product datasheets for all products specified under this section.
2. Clearly state all model numbers on all submittals.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

    a. OmegaFlex, Inc.
    b. Parker Hannifin Corporation; Parflex Division.
    c. Titeflex.
    d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.

3. Coating: PE with flame retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: Tubing shall be rated for 25 psig.
8. Tubing must have elevated pressure ratings of 125G for sizes up to 1-1/4 inches for high-pressure applications permitted by the Local Distribution Utility. These elevated pressure ratings shall be demonstrated by test reports from the certification agency.

C. Pre-Sleeved and Vented, Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Underground piping shall consist of corrugated, stainless-steel tubing sleeved with a black integral polyethylene sleeve. The external polyethylene sleeve shall be designed to withstand the superimposed loads. The external protective sleeve shall have internal vent channels lengthwise to direct any leakage along the pipe to the end fittings.
2. For gas piping under building slabs, Plumbing, Mechanical and Fuel Gas Code requirements shall be followed for encasement within a conduit and venting to the atmosphere. The construction of the pre-sleeved system shall provide the encasement and venting capabilities required by the codes.
3. Underground fittings may be used within the system. All metallic parts of the buried fittings shall be wrapped in a code-approved manner (e.g. mastic used for wrapping metallic pipe). Underground fittings are not permitted under the slab of a building.
4. The underground piping system shall be listed by either ICC or IAPMO for use in underground or underground beneath building applications.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.

3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Description:

   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig minimum at 180 deg F.

d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.6 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close localized appliance and equipment shutoff valves before turning off natural gas to premises or piping section.

B. Comply with all local utility authorities and NFPA 54 for installation and purging of natural-gas piping.

3.2 OUTDOOR PIPING INSTALLATION

A. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

3.3 INDOOR PIPING INSTALLATION

A. Install piping free of sags and bends.

B. Install fittings for changes in direction and branch connections.

C. Verify final equipment locations for roughing-in.

D. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

E. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

F. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

G. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

I. Connect branch piping from top or side of horizontal piping.

J. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

K. Do not use natural-gas piping as grounding electrode.

L. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance and/or equipment.

B. Ensure valves are readily accessible, maintainable, replaceable, repairable, and can operate from the fully open to fully closed position.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
2. NPS 3/4 and NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/4 and NPS 1-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 108 inches; minimum rod size, 1/2 inch.
5. NPS 2-1/2 to NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.
7. NPS 6: Maximum span, 10 feet; minimum rod size, 3/4 inch.
8. NPS 8: Maximum span, 10 feet; minimum rod size, 7/8 inch.

B. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
2. NPS 3/4: Maximum span, 84 inches; minimum rod size, 3/8 inch.
3. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
2. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.7 CONNECTIONS

A. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.8 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, fittings, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties. Paint exterior piping to match building exterior.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel flat.
d. Color: To match surroundings and shall be approved by architect.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex flat.
d. Color: To match surroundings and shall be approved by architect.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd flat.
d. Color: To match surroundings and shall be approved by architect.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 INDOOR HOUSE PIPING SCHEDULE (INTERIOR PIPING DOWNSTREAM OF METER)

A. Aboveground indoor house piping shall be:

1. For piping 2” and smaller: Steel pipe with malleable-iron fittings and threaded joints.
2. For piping larger than 2”: Steel pipe with wrought-steel fittings and welded joints.
3. Corrugated, Stainless-Steel Tubing

3.10 OUTDOOR HOUSE PIPING SCHEDULE (EXTERIOR PIPING DOWNSTREAM OF METER)

A. Aboveground outdoor natural-gas piping shall be:

1. For piping 2” and smaller: Steel pipe with malleable-iron fittings and threaded joints.
2. For piping larger than 2”: Steel pipe with wrought-steel fittings and welded joints.

B. Underground outdoor natural-gas piping shall be:

1. Polyethylene pipe and fittings joined by heat fusion, or mechanical couplings if allowed by the utility provider; service-line risers with tracer wire terminated in an accessible location. Polyethylene piping shall meet the requirements of ASTM D2513.
2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings is allowed by the utility provider. Coat pipe and fittings with protective coating for steel piping.

3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 221613

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data:

1. Provide product datasheets for all products specified under this section.
2. Clearly state full load amps (FLA), voltages (where applicable) and model numbers on all submittals.
3. Include material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
4. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
5. Include diagrams for power, signal, and control wiring of automatic fixtures where applicable.

1.2 EXTRA MATERIALS

1. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents as indicated below:

    a. Filter Cartridges for Drinking Fountains and Water Coolers: Equal to 20 percent of quantity installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS AND WATER COOLERS

A. Drinking Fountains and Water Coolers:

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. Elkay Manufacturing Co.
    b. Kohler Co.
    c. Belson Outdoors, Inc.
    d. Haws Corporation.
    e. Petersen Manufacturing Co., Inc.
    f. Sanderson Concrete Inc.
    g. Stern-Williams Co., Inc.
    h. Halsey Taylor.
    i. Most Dependable Fountains, Inc.
    j. Murdock-Super Secur; a division of Acorn Engineering Company.

2.2 SUPPLY FITTINGS

A. Standard: ASME A112.18.1/CSA B125.1.

B. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

C. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

D. Risers:

1. NPS 1/2.
2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces, chrome-plated, soft-copper flexible tube, ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Fixture Installation:

1. Install fixtures level and plumb according to manufacturer’s rough-in drawings.

B. Traps:

1. Install traps on fixture outlets.

a. Exception: Omit trap on fixtures with integral traps.
b. Exception: Omit trap on indirect wastes unless otherwise indicated.

C. Drinking Fountain and Water Cooler Installation:

1. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
2. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

END OF SECTION 224000

SECTION 230170 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Closeout

1. Operation and Maintenance Manual: For equipment and systems to include in operation and maintenance manuals.
2. As-Built Drawings: For recording installed conditions that deviate from design documents.

1.2 OPERATING AND MAINTENANCE MANUALS

A. The contents of operating and maintenance manuals shall include the following:

1. Project Information Cover: Title of Project; Name and address of Owner, Design Professionals, Contractor of Record and Subcontractor; System name and specification references.
2. Index: Contents of the manual.
3. Warranty Statements: Furnish a warranty statement for each system, reiterating the terms of warranty identified within the Contract Documents, and identifying how the Owner is to obtain warranty service. Clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 1-year parts and labor). Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion. Supply standard out-of-warranty service rates and service contact information.
4. Bill of Materials: List of products supplied, and serial numbers of each product.
5. Product Datasheets and Shop Drawings: Manufacturer datasheets and shop drawings for each product and system supplied.
6. Manufacturer Owner / User Manuals: Manufacturer’s Owner’s or User’s manual for each product, and Manufacturer’s Installation instructions and other documentation supplied with the product.
7. Spare and Replacement Parts Schedule:

    a. Complete spare parts schedule for components of equipment furnished, which are not factory generic information, but accurate for the equipment provided.

8. Maintenance Procedures: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; testing, aligning and adjusting instructions.
9. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments. Function and Operating Descriptions: Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
10. Operating Procedures: Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.

11. Test Reports and Checklists: Test reports, checklists, and other forms generated and completed for the Project.
12. Training Information: Copy of training outlines/agendas, training session handouts, training sign-in sheets, and signed delivery receipt for each training session recording; Separate USB drive, labeled, for audio/video-recorded instructions to Owner, for operations and maintenance for each system.
13. As-Built Drawings.

B. Organization - A manual of such purpose shall be arranged in two parts, with Part I dealing with information pertaining to systems and Part II covering information pertaining to equipment. These may be bound in as many volumes as may be required for convenience of use and reference.

1. Part 1 - Systems:

a. The systems volumes shall be organized into Divisions wherein each Division represents a generic function. Systems shall be classified under appropriate Divisions. An example of such an arrangement is as follows:
b. Division Title Division No.
   1) Cooling 1.0
      a) Air Conditioning
      b) Refrigeration
   2) Heating 2.0
   3) Ventilating
      a) Toilet Exhaust

c. The material for each system shall be organized in sections descriptive of the following basic areas of information:
   1) Descriptive Information.
   2) Operating Instructions.
   3) Inspection and Maintenance Instructions.

d. Sections could be organized to include the following categories of information:
   1) Descriptive Information
   2) Function of service.
   3) Classification.
   4) Design capability.
   5) Performance characteristics.
   6) Principal components.
   7) Distribution arrangement.
   8) Schematic diagram.
   9) Control diagram.
   10) Equipment Data.
   11) Inventory designation.
   12) Manufacturer and model.
   13) Size and rating.
   14) Pressure, speed and temperature limitations.
   15) Operating Instructions.
   16) Starting and stopping procedures.
   17) Adjustment and regulation.
   18) Seasonal start-up.
   19) Seasonal shut-down.
   20) Logs and records.
   21) Inspection and Maintenance.

22) Inspection schedule and checklist.
23) Schedules and procedures for lubrication, replacements, adjustment, cleaning, painting, protection and testing.
24) Inspection and maintenance records.

e. Reference Documents:
1) Construction drawing list.
2) Construction specifications.
3) Record drawings.
4) Test and balance records.

2. Part 2 - Equipment:

a. This part of the manual shall be composed of manufacturers and fabricators data on equipment and materials organized into divisions wherein each division represents a generic classification of equipment such as:
b. Division Title
1) Air Conditioning and Ventilating
2) Controls
3) Instrument and Accessories
4) Motors
5) Refrigeration
6) Starters
7) Valves

c. Each division shall be organized in sections wherein each section would represent a specific type of equipment in Division 1, the sections shall include the following:
1) Air Conditioning and Ventilating
a) Coils - Cooling
b) Preheat
c) Reheat
2) Fans
a) centrifugal
b) propeller
c) Filters – Roughing
3) Humidifiers – central

d. Each section shall include the following manufacturer information:
1) Descriptive Literature
a) Catalog cuts, brochures or shop drawings
b) Dimensional drawings
c) Materials of construction
d) Parts designations
2) Operating Characteristics
a) Performance tables and charts
b) Performance curves
c) Pressure, temperature and speed limitations
d) Safety devices
3) Equipment Startup Sheets
a) Complete equipment configuration settings
4) Operating Instructions
a) Pre-start check list
b) Start-up procedures
c) Inspection during operation
d) Adjustment and regulation

e) Testing
f) Detection of malfunction
g) Precautions

5) Inspection Instruments and Procedures
   a) Normal and abnormal operating temperature, pressure and speed limits
   b) Schedule and manner of operation
   c) Detection signals
6) Maintenance Instructions and Procedures
   a) Schedule of routing maintenance
   b) Procedures
   c) Troubleshooting chart
7) Parts List
   a) Spare Parts
   b) Essential inventory
   c) Distributor directory
8) Service and Dealer Directory
9) Service Contracts

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTRUCTIONS FOR THE OWNER'S PERSONNEL

A. Train or engage for factory-authorized service representative to train Owner's operating and maintenance personnel. Provide instruction in the proper operation and maintenance of equipment that requires routine servicing. Include the following:

1. Review of operation and maintenance manuals.
2. Required tools.
3. Lubricants.
4. Spare parts.
5. Cleaning.
6. Hazards.
7. Warranties and maintenance agreements.

B. Demonstrate equipment and systems operation including the following:

1. Start-up.
2. Shut-down.
3. Emergency conditions.
4. Safety procedures.
5. Setpoint and schedule adjustments.
6. Economy and efficiency adjustments.

END OF SECTION 230170

SECTION 230501 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Shop Drawings

1. Coordination Drawings: This contractor shall provide necessary coordination drawings required to make sure all disciplines are coordinated and fit into specified spaces (i.e. ceilings, chases, and all others). It is the work of the contractor to prepare complete coordination drawings indicating exact location, clearances and penetrations of all items of all trades.

1.2 RELATED DOCUMENTS

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

1.3 GENERAL DIRECTION

A. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and had an opportunity to visit the site to be able to provide a comprehensive complete bid.

B. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes. Interpret these specifications in conjunction with the drawings and provide all work described. If work is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both. Should there be a conflict between the specifications and drawings, provide the greater quantity or better quality. Immediately notify owner's representative and design professional of such conflicts.

C. The drawings that accompany these specifications are diagrammatic and although size and location of equipment is drawn to scale wherever possible make use of submittal data and verify all dimensions on site. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Follow the drawings as closely as is practical and install additional bends, offsets and elbows where required by site conditions and codes at no additional cost. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, all measurements should be taken in the field.

D. Coordinate all work with all other contractors and installers in addition to existing building obstructions and install accordingly. Comply with requirements of architectural drawings including but not limited to mounting height and locations. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

E. Complete work, or part(s) thereof, at times as may be designated by the Owner's Representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of it by Owner.

F. During mobilization or construction, if an abnormal condition is uncovered either with existing conditions, equipment loads, submittal data, etc. bring these to the attention of the Design Professional for review.

G. Owner's Representative or Design Professional may relocate devices prior to installation within a 20-foot limit at no additional charge.

H. All ducts and piping shall be run as straight as possible and symmetrical with architectural items. Piping shall be concealed in pipe shafts, pipe spaces and furring wherever possible. Ductwork and piping fabricated before coordination with the other trades will be done at the contractor's risk.

1.4 GENERAL STANDARDS

A. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest edition of applicable standards and adopted codes, including (but not limited to) the following.

1. State Building Code and applicable local amendments.
2. Local Building Code (if applicable)
3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
4. American Society of Test Materials (ASTM)
5. National Fire Protection Association (NFPA)
6. Underwriters Laboratories (UL)
7. National Sanitation Foundation (NSF)
8. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
9. American National Standards Institute (ANSI)
10. Building Code Seismic Relative Displacement Requirements

1.5 PERMITS AND REGULATIONS

A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this branch of the work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.

B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor and are hereby made a part of this contract.

1.6 DEFINITIONS

A. Furnish - Procure, supply and deliver to project site, ready for installation, install and warrant (unless indicated otherwise on documents). Include warranty expenses.

B. Install - To supply labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order render the respective product and system fully operational and usable to the Owner for the intended purpose

C. Provide - Furnish and Install. Similar Terms: "include", “shall”, “equip with”, “consisting of”.

D. Equal or Equivalent - Determination of equivalency to be made by design professional for all products not listed as basis-of-design.

E. Substantial Completion - Where frontend documentation does not define, products and systems must be fully installed as designed, tested, adjusted, labeled, and functionally demonstrated to owner.

1.7 REQUESTS FOR INFORMATION

A. Submit all questions, requests for information (RFIs) and similar queries through the formally-established RFI process for the project that has been accepted by the Owner’s Representative, Design Professionals, Prime Contractor and subcontractors. Submit as a PDF file. Do not submit as text in an email.

1.8 AVAILABILITY OF ELECTRONIC DRAWINGS

A. If expressly permitted by the Owner and the terms of the Contract, editable electronic drawings may be made available for the creation of shop and as-built drawings upon request. Drawings will be made available at the discretion of the Engineer.

B. “Request Drawings” form can be accessed, filled out and submitted at http://www.klhengrs.com (right hand side of page - Contractor Resources). Direct access to this form can be found here: http://files.klhengrs.com/requestdrawings.html

1.9 QUALITY ASSURANCE

A. Contractor shall have a minimum five (5) years experience in the installation of systems similar to the systems specified. Contractor, if requested, shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor’s inability to perform.

1.10 WARRANTY / GUARANTEE

A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner’s option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working

days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Provide materials that are new, full weight, of the best quality. Obtain equipment, components and materials from single manufacturer for products of the same kind or category. Provide materials that are listed and labeled and marked for intended location and application.

B. Provide basis of design products or listed products equivalent in quality, performance, aesthetics, and product support (factory and local) to that specified as basis of design. Products not basis of design are subject to review by the Design Professional and possible rejection. Listing of a product manufacturer by name alone as an equivalent manufacturer shall not equate all products offered by that manufacturer to the basis of design.

C. Bear all costs incurred from deviation from basis-of-design materials, methods, labor, services, etc. Use of materials, methods, labor, services, etc. that deviate from the basis-of-design will be considered a statement that capacities, requirements, clearances, arrangements, performance, etc. have been checked, verified, found satisfactory, and align with intent of specified work and applicable codes and regulations.

D. Should deviation from basis of design equipment impact other contractors scope of work it shall be the responsibility of this contractor to coordinate with and cover these costs in addition to their own. This specifically includes electrical deviations from basis of design.

E. All manufacturer or contractor provided electrical disconnect switches shall comply with current National Electric Code requirements and rated to meet or exceed the overcurrent device serving the equipment.

PART 3 - EXECUTION

3.1 GENERAL DIRECTION

A. Unless specifically indicated, provide all specified and drawn work as required to render all equipment and systems fully operational, including all ancillary, accessory, and support work. Install equipment and materials in strict accordance with manufacturer's written instructions.

B. In cases where products / materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.

C. Remove and replace items that impede new work installation including but not limited to fencing, doors, gypsum, lift-out panels, and structures to provide pathway for moving equipment into place.

D. Examine surfaces to receive products for suitable mounting conditions and verify compliance with installation tolerances and other conditions affecting performance of the work. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Equipment shall be installed in accordance with manufactures installation recommendations. Provide and maintain service, maintenance and operating clearances as required by the manufacturer.

3.2 SUPERVISION AND WORKMANSHIP

A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.

B. Contractor shall furnish the services of an experienced superintendent to be in constant charge of the work at all times. The superintendent's qualifications are subject to the review and acceptance by the Owner's Representative. Utilize the same mechanical superintendent throughout the duration of the project.

C. Provisions shall be made for owner’s representative or design professional to make rough-in and open ceiling inspections prior to covering up work.

3.3 CHANGE OF WORK

A. In the event of revised scope or work formally issued through Change of Work order, contractor shall provide an itemized breakdown of pricing and receive approval prior to commencing work.

3.4 ARCHITECTURAL COORDINATION ITEMS

A. Cutting and Patching:

1. Cut and drill all openings in roofs, walls, and floors required for the installation. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started.

B. Fire Caulking:

1. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
2. Provide products equivalent to the following:

   a. For Floor Openings: 3M; Fire Barrier Sealant CP 25WB+
   b. For Wall Openings: 3M; Fire Barrier Sealant CP 25WB+
   c. Mineral Felt: Rockwool; Firepro Firestop Compound
   d. For Insulated Pipes: 3M; Fire Sealant System CAJ5211
   e. For Fill Areas: 3M; Fire Barrier Packing Material PM 4

3. For larger openings where pipes penetrate fire rated enclosures that cannot be sealed with products described above, utilize approved UL products equal to 3M FireDam Spray 200.

C. Access Panels:

1. Provide all access panels required for proper servicing of equipment. Provide fire rated access panels at fire rated assembly penetrations rated at or above the fire rating of the assembly. Provide frame as required for finish. Coordinate installation with General Contractor as they may elect to install access panel. Exact location(s) must be approved by the Architect. Minimum size to be 12" x 12", units to be 16-gauge steel, primed for paint, and locking device shall be screwdriver cam locks.
2. For equipment above gypsum board or “hard ceilings”, provide equipment access panels sized to permit complete holistic removal of the unit in its entirety. Access panel shall also be sized to accommodate removal of the largest piece of equipment in the case where such access panel is used as a removal pathway for multiple pieces of equipment.

D. Piping Sleeves:

1. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction. Cut flush with both faces of wall. Floor sleeves shall extend one inch above floor top elevation. Roof penetrations shall be within a pipe curb assembly equal to Pate Co. Curb and flashing per roofing manufacturer’s requirements to maintain warranty.
2. Install rockwool and/or caulk between pipe and sleeve. Material must meet all applicable fire ratings.

E. Piping Escutcheon plates:

1. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.

F. Expansion Joints:

1. Provide flexible connectors where all pipes or ducts cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of piping or ductwork.

3.5 PROTECTION OF SURFACES

A. Make every effort to protect roofs, walls and floors from foot traffic, equipment, carts, lifts, etc.

B. Make roof penetrations and install insulated roof curbs and flashing in accordance with roofing manufacturer’s recommendations. Obtain written certification from roofing manufacturer that work has been performed properly and that roof warranty is intact.

3.6 UTILITY VERIFICATION REQUIREMENTS

A. Field verify locations of underground and aboveground utilities, or those otherwise obscured from view, in the vicinity of work prior to commencing work. Utilize “811” call before you dig and hire locating service to identify, locate and mark remaining utilities and private lines.

B. Camera scope and dye testing existing piping, ductwork and pathways to confirm existing conditions and use including, but not limited to, voltage, natural gas pressure, sanitary, storm, chilled water, steam, etc.)

C. Obtain on-site approval from local utility prior to connecting to existing services.

D. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

3.7 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Receive, inspect, store and protect all materials required for new work. Do not accept or install any product damaged in any way.

B. Comply with all manufacturer guidelines and requirements for movement, storage, and protection of new work. All new work must be stored in a clean, dry place protected from weather and construction traffic. Maintain acceptable temperature and humidity per manufacturer recommendations. When stored inside or during transport through building, do not exceed structural capacity of the floor.

C. Coordinate and account for sizes of all new work included shipping materials with available openings. Account for rigging of all new work as required and as intended by manufacturer.

D. Do not install work until work area is sufficiently weathertight, all wet work in area is complete and all work above is complete.

E. Prior to installation, all products shall have the ability to be returned to the supplier or manufacturer after purchase and charged a reasonable restocking fee equal to a small portion of the cost.

F. Protect all new work through construction from damage. Take safeguards necessary to protect from damage. Items damaged during construction will not be accepted and shall be replaced with new.

G. Remove and replace all materials that have been installed improperly, physically damaged, moisture or water damaged, or mold damaged.

H. Fully remove all packaging materials inside and out prior to startup.

3.8 FIRE ALARM RELATED WORK FOR MECHANICAL SYSTEMS

A. The drawings and specifications for this project require specific fire alarm devices, connections, wiring and programming associated with this division of work.

B. The electrical contractor will be installing a new fire alarm system or making modifications to an existing fire alarm control panel. Coordinate all fire alarm connections and programming that will be required with the electrical contractor to fulfil this division of work. This coordination shall

take place at the start of the project so that all devices may be shown on fire alarm shop drawings.

C. Fire alarm devices to satisfy the requirements of this division of work will be furnished by the electrical contractor, installed by the mechanical contractor, wired and programmed by the electrical contractor. Mechanical and electrical contractor shall perform and be present for all tests of the system.

D. All required mechanical shutdowns of equipment shall be coordinated with the electrical contractor and with submitted equipment and performed in a controlled and safe manner in the presence of smoke. This shall be done via hardwired contacts and not via Building Automation System.

3.9 STARTUP, TESTING AND ADJUSTMENTS

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Unit may be started up and utilized only after the floor has been prepared and after drywall sanding has occurred 100%. Coordinate with all trades prior to startup.

B. Adjust hardware and moving parts to function smoothly and lubricate as recommended by manufacturer.

3.10 CLEANING EQUIPMENT AND PREMISES

A. Vacuum, clean and wipe down all new work and equipment inside and out. Exposed parts which are to be painted shall be cleaned of all foreign objects and prepped for paint.

B. During the progress of work, clean up and leave the premises and portions of the building in which work has occurred in a clean and safe condition. Provide this cleaning on a per-shift basis.

3.11 DEMONSTRATION / TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to product specific specification for training types and duration.

END OF SECTION 230501

SECTION 230503 - SUBMITTALS FOR HVAC

PART 1 - GENERAL

1.1 GENERAL

A. The contractor is not relieved of responsibility for providing specified or drawn scope of work should any errors or omissions in submittal information not be noted by the Design Professional during submittal reviews or site observations.

B. Submittal requirements of this section apply to all Division 23 sections. Note that some Division 23 sections may also have additional requirements that are unique to the specific section, which would be requirements in addition to those stated in this section. Furnish submittals for each Section that includes one or more of the following elements of work: supply, installation, integration, programming, creation, labeling, and/or contractor-based design or engineering, of one or more products or systems.

C. Furnish submittals in electronic (PDF) format. Provide electronic submittal files that are compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard. Assemble single PDF file submittals from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked if needed to aid the reviewer in navigating the content. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., 230993-PD-01.pdf).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Route submittals through established Project channels as identified by the Owner's Representative. Coordinate, assemble, title, transmit and track Project submittals. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall have the same appearance and organization as those of other Sections. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections may include additional requirements. Design Professional reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis.

B. Furnish submittals for all materials proposed for use for the project, using products compliant with all respective specifications and with information shown on drawings. Furnish submittals for different Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Section at a time. Organize submittals as identified in the Contract Documents. Supply separate submittals for each Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents. The format for labeling the submittals shall be as follows: Section Number–Submittal Type Abbreviation–Submittal Iteration (examples: First Product Data Submittal for

Section 230993: “230993-PD-00”; revised Product Data Submittal for Section 230993: “230993-PD-01.”).

3.2 SUBMITTAL REQUIREMENTS

A. General:

1. Transmittal: Supply a dedicated transmittal for submittals for each individual Section. Itemize the specific submittals included by Section, submittal type, and iteration.
2. Title Sheet: Include a separate title sheet (including index) with each submittal, of each type. Title sheets for each Section, for each submittal type, shall have the same appearance, 8-1/2 inches x 11 inches for product data submittals. Title sheets for drawings shall be the same size as the associated drawings. Create title sheets with appearance and information identified on the sample title sheet at the end of this Section.
3. Title Blocks: Create drawing submittals on the Contractor’s, manufacturers, or vendor’s own title block, not using those of the Owner, Design Professionals or their Consultants.
4. Legend: Drawing submittals shall include a legend of symbology.
5. Resubmittals: Resubmittals shall include a replica of the reviewer’s comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.
6. Submittal requirements indicated in this section apply for all specification sections with products and materials, and are supplemental to and in addition to submittal requirements that may be included in product and material specification sections.

B. Informational Submittals – Submit this information as part of the Operations and Maintenance Manual.

1. Product Certificates: For each applicable product or system, from manufacturer.
2. Source quality-control test reports.
3. Field Quality-Control Reports:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Quality Assurance Submittals (QA):

1. Furnish upon request when not expressly requested to be supplied with bid. When requested, furnish to the Design Professional within 2 business days.

    a. Qualification Data for testing agencies, including detailing of scope of services for the project.
    b. Furnish list of Subcontractors to be used on the Project along with a description of the role each shall play on the Project, and the last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value.

D. Product Data Submittals (PD): Submit following contract award or notice of intent to award a contract. Submit and obtain review(s) prior to procurement or fabrication of materials. Provide separate manufacturer datasheets for each product, which shall be manufacturer originals of the manufacturer’s official electronic datasheet. Distributor modified, distributor branded, and/or

html based “web” datasheets are not acceptable. For all materials, equipment, components and ancillary materials, include the following as applicable: voltage; phase; frequency; short circuit ratings; load; dimensions; technical data; enclosure types; required clearances; weights; methods of field assembly and installations; diagrams; configurations; capacities; finishes; construction; overcurrent protection; features; performance; electrical characteristics ratings; finishes; accessories; NRTL listing for series rated devices; time-current coordination curves for each type and rating of overcurrent protective device, including selectable ranges for each; all pertinent technical support data; factory settings; etc. Where manufacturer’s datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or bold visible arrows the models, versions, colors, options, etc. being supplied. Indicate and identify exact catalog numbers. Comply with applicable standards of UL or NRTL.

E. Shop Drawing Submittals (SD): Submit following contract award or notice of intent to award a contract. Submit and obtain review(s) prior to procurement or fabrication of materials. Submit concurrently with section-specific product data submittals where both apply. Draw plans, elevations, sections, elevations and sizes to scale. Show and details, features, characteristics, ratings, factory settings, nameplates, legends, bus structure, capacities, features, accessories, locations of pertinent items, schematics, wiring diagrams, production drawings, etc. Furnish schematic drawings with all information required to install, identify, connect, wire, program, maintain, etc. the system(s). Comply with applicable standards of NRTL.

F. Sample Submittals (SS): Submit concurrent with, or soon after, product data and shop drawings and prior to installation of Work. Furnish physical samples where applicable, in quantities as directed by Owner’s Representative.

G. Training Submittals (TG): Submit thirty (30) days prior to the first training session. Furnish proposed schedule, training agendas for each session, identification of personnel that will conduct training, and handouts proposed for distribution during training. Record all training sessions and include within O&M Manual.

H. Closeout Submittals (CO):

1. Submit following completion of onsite work.
2. Operation and Maintenance Manuals:

    a. Provide on USB drive(s). Provide sub-directories on the drive(s) to label and separate contents for the manual.

3. As-Built Drawings

    a. Provide on USB drive(s).

I. Extra Materials: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Generate report indicating all maintenance materials turned over to owner and obtain signature from owner acknowledging receipt.

3.3 SUBMITTAL RESPONSES

A. Revise and Resubmit: When a submittal is marked “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality unless specifically indicated otherwise.

Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon. Uniquely identify specific portions of each resubmittal that have been modified since the previous version was reviewed. Resubmittals shall include a copy of the reviewer's previous comments, include a written description of the action(s) taken, be labeled chronologically, and be inclusive of all corrective action identified by the previous reviewer.

B. Exceptions Noted: When a submittal is marked "Exceptions Noted," the specific actions identified shall be taken. No further submittal actions required

C. No Exceptions: When a submittal is marked "No Exceptions", no further actions are required.

END OF SECTION 230503

SUBMITTAL TITLE SHEET
EXAMPLE
(Form: Sub-1)

PROJECT TITLE:

Project Name Line 1
Project Name Line 2
Project Name Line 2

SUBMITTAL TYPE:

Product Data

SECTION SUBMITTAL NUMBER

233113-PD-00

SECTION TITLE:

Metal Ducts

Date Prepared:

yyyy-mm-dd

CONTRACTOR OF RECORD:

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SECTION 230505 - EXISTING CONDITIONS AND DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Prior to submitting a bid, the Mechanical Contractor shall perform a detailed walk-through field inspection, to review the existing structures and premises, to determine all existing conditions, equipment/ductwork/piping locations, etc. and shall make all necessary allowances for all required mechanically related demolition and relocation work. This pre-bid inspection by the Mechanical Contractor shall include inspection of all applicable accessible ceiling cavity, areas, etc.

B. Should the Mechanical Contractor take any exceptions to providing any related demolition or relocation work, such exceptions shall be stated in detail within the Prime Contractor's bid. No subsequent allowance to the contract cost shall be made for any insufficient allowances made by the Mechanical Contractor during bidding which may result from the Mechanical Contractor's failure to visit job site and review drawings.

C. The Mechanical Contractor shall confirm the working operation and condition of existing systems to remain. The Mechanical Contractor shall note any malfunctioning systems, system deficiencies or any other noteworthy system items prior to commencement of work. The Mechanical Contractor shall provide a written systems condition assessment report to the owner prior to commencement of work. The owner shall sign the assessment report acknowledging the condition of the existing systems. The Mechanical Contractor shall protect these existing systems and shall be responsible for these systems during demolition and construction. The Mechanical Contractor shall be responsible for turning these existing systems back over to the owner in the same operating condition as the contractor received it. The mechanical contractor shall be responsible for repairing or replacing any malfunctioning systems, components or deficient systems to the satisfaction of the owner that have not been noted on the written systems condition assessment report. The mechanical contractor shall be responsible for all existing system components and operation in the absence of an owner-signed systems condition assessment report.

D. Demolition related work may not be specifically indicated on drawings, but shall be included under base bid. All mechanically related demolition, relocation, etc. work, including work described herein, shall be under base bid.

E. It is not the intent of these contract documents that existing conditions be accurately shown. Existing mechanical work is shown to a limited extent on drawings and is shown for general planning reference only. Such locations, etc. have been located from portions of contract documents which were prepared for previously installed work (not from "as-builts"). These locations are not guaranteed. The successful Mechanical Contractor shall have access to all available existing building/system plans and specifications.

F. The existing ductwork and piping systems may be utilized only to the extent indicated herein or on drawings and/or as directed by Owner's representative in field.

G. Routing of all new ductwork and piping work in existing buildings shall be approved by Owner's representative prior to installation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EFFECT ON ADJACENT OCCUPIED AREAS

A. Locate, identify, and protect existing mechanical services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services (including proper filtration) for affected areas.

B. It is recognized that there may be some ductwork and/or piping systems rendered inactive by demolition, causing disconnection of "downstream" terminals, equipment, etc. which serve occupied areas. It shall be the responsibility of the Mechanical Contractor to investigate these types of conditions (for all systems) prior to demolition. Provide all necessary corrective mechanical work prior to demolition to ensure that such "downstream" work remain permanently active throughout demolition, new construction and after project completion.

C. All work and system shutdowns shall be carefully coordinated in advance with owner's representative and all affected trades so that normal building activities and other construction trades are minimally affected. All required mechanical related demolition and/or new construction work, which will affect any and all occupied areas (including those which are located outside the immediate area of project work) shall be performed at special times if/as directed by Owner's representative in field.

D. All existing systems and components shall remain fully operational in all occupied spaces during all occupied periods.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and/or other system components. During cutting and patching operations, protect adjacent installations. Remove protection and barriers after demolition operations are complete.

3.2 WORK IN EXISTING SPACES

A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.

B. Existing Ceilings: Where work is being performed above existing ceilings, and the architectural drawings do not indicate ceiling modifications by the General Contractor, it shall be the responsibility of this contractor to remove and replace existing ceilings where work is being performed. In those instances, all repair and installation of new grid, ceiling panels, etc shall be the responsibility of this contractor. Match existing finishes.

C. Walls & Floors: It shall be the responsibility of this contractor to patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.

D. HVAC Units: Replace all air filters in all HVAC equipment serving renovated space prior to turning space over to owner.

E. If asbestos, PCB's, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

3.3 GENERAL DEMOLITION

A. Provide complete mechanical demolition as required for all systems throughout all project areas not indicated to be salvaged or saved. Unless specifically noted otherwise on plans or determined otherwise during this contractor's pre-demolition survey, all abandoned existing mechanical work in the project areas shall be disconnected and removed in its entirety by the Mechanical Contractor. All related work shall comply with the notes specified herein.

B. Provide demolition work as required to clear and remove all existing mechanical work to be abandoned and as required to accommodate all new work of all trades. In general, remove existing related ductwork, piping, control media, etc. back to nearest concealed accessible terminal or take-off "upstream". Extend ductwork, piping, etc. as required to accommodate new or relocated mechanical work.

C. Remove abandoned, inactive and obsolete equipment, ductwork, piping, etc. Abandoned work embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove all abandoned materials above accessible ceilings.

D. Perform cutting and patching required for demolition in accordance with the contract documents.

E. All abandoned ductwork and piping shall be removed and capped back to respective sources, even if sources are outside of the confines of the project area. Coordinate all work carefully with Owner prior to beginning any mechanical demolition work.

F. All ductwork, piping, etc. conflicting with construction related work of any and all trades shall be removed and/or relocated by the Mechanical Contractor as necessary and/or as directed by Owner's representative in the field. Mechanical disconnections (and/or reconnections) for equipment to be removed (and/or relocated) shall be by the Mechanical Contractor. This shall apply to all existing mechanical work whether shown on drawings or not.

G. All refrigerant evacuations and reclaim shall be required for demolished or relocated equipment.

H. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

I. Provide new work as required to accommodate relocations, etc. Routing of all new ductwork and piping in existing buildings shall be held tight to structure above wherever possible and shall be approved by owner's representative prior to installation.

3.4 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

A. If required to accommodate construction related activities, remove and reinstall any conflicting fixtures, devices or equipment that are to remain.

B. All abandoned materials removed during demolition and thereafter shall be referred to the Owner's representative for disposal instructions. All materials which the Owner elects to retain shall be neatly stored at the site by the Mechanical Contractor as designated by the Owner's representative. All materials which the Owner elects not to retain shall be disposed of by the Mechanical Contractor in a lawful manner.

C. All fixtures, devices or equipment designated for salvage (removal and reuse, or for turning over to Owner) shall be disconnected and removed undamaged. Disconnect all pigtails, etc. from equipment terminal points and carefully transport and neatly store same to a protected on-site storage location as directed in field.

D. Components to be reused shall be cleaned (inside and out) and reinstalled where indicated on drawings. Modify and/or extend related existing ductwork and/or piping as required.

E. Components turned over to Owner shall be neatly stored as groups by system type.

3.5 PRE-EXISTING CODE VIOLATIONS

A. All existing work which is accessed and/or used under this project shall be inspected and brought into compliance with current codes and standards by the Mechanical Contractor. This shall apply only to the extent that such work is uncovered in the immediate project areas affected by demolition and/or new construction and only to the limited extent that it applies to pre-existing general installation methods (i.e. a missing hanger/support, a missing seal and other minor incidental work.

B. If more extensive code or safety violations are discovered by the Mechanical Contractor, they shall be immediately brought to the attention (detailed in writing) of the Owner's representative along with the contractors proposed cost for corrections.

3.6 INTERIM LIFE SAFETY WORK

A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

3.7 INTERIM INDOOR AIR QUALITY (IAQ) WORK

A. All requirements of this IAQ subsection shall be implemented prior to commencement of any demolition/construction activities.

B. No airborne dust or particulate matter shall be permitted to enter any occupied spaces or any air intakes to existing systems.

C. Become familiar with all affected HVAC systems to ensure that positive pressure can be maintained, relative to construction areas, in all areas adjacent to construction areas. This shall include all possible operational sequences of all systems such, including operation of smoke control, fire dampers, etc.

D. All return air and exhaust air terminals within all demolition/construction spaces shall be covered and properly sealed until construction is complete.

E. All air filters shall be checked at the beginning and end of each work shift and shall be changed in-kind as required to permit free airflow at all times.

F. Provide temporary exhaust throughout all demolition/construction spaces to ensure proper negative pressure is maintained relative to adjacent areas, including allowances for normal construction traffic through all access doors. Ensure that no windows or doors are left open which could upset the desired negative pressure.

G. Designate a dedicated qualified person to be on site to monitor all IAQ requirements, including checking filters three to four times per shift, checking for any breeches (by any contractor) such as drilled/cut openings in walls/floors, open windows, etc. Ensure that openings through walls and floors (by any contractor) are made immediately prior to installation of work and properly/permanently sealed immediately thereafter.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All mechanical equipment shall be UL listed.

B. The motor control apparatus shall be furnished complete as a part of the motor and apparatus which it operates when called for in certain instances in the Mechanical Division. Motor control apparatus except as above shall be complete, factory wired and tested, ready for connections to be made under Division 26.

2.2 MOTORS

A. All motors shall be in accordance with the latest standards of NFPA 70, "National Electrical Code".

B. Wherever in these specifications, a motor voltage is listed, the motor shall be wound for the listed voltage and none other will be accepted.

C. Service Factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors, which will operate in the service factor range when supply voltage is within 10 percent of motor voltage rating.

D. For motors controlled with a variable frequency drive, provide grounding rings and brushes on motor shaft to divert shaft to ground current flow around bearings.

E. Temperature Rise: Based on 100 degree F ambient except as otherwise indicated.

F. Three-Phase Motors

1. Squirrel cage induction type.
2. NEMA design letter Designation "B".
3. Internal thermal overload protection.
4. Bearings: double shielded, prelubricated, regreasable.
5. Energy Efficient Motors: equal or greater than NEMA MG-1.
6. 1.25 Service factor.
7. Multi Speed Motors: separate windings for each speed.

G. Single-Phase Motors

1. Internal thermal overload protection.
2. Motor starters incorporated as an integral part of equipment shall be NEMA standard.
3. Sealed, prelubricated bearings.

PART 3 - EXECUTION

3.1 ELECTRICAL INSTALLATION

A. All electrical work associated with this section shall be in accordance with the latest standards of NFPA 70, "National Electrical Code".

B. Electrical wiring shall be provided under Division 26 unless specifically called for in another section of the specifications.

C. An enclosed safety type, NEMA Type HD motor disconnect switch shall be furnished and installed for each motor installation unless specifically mentioned as furnished under another section of these specifications.

3.2 STARTUP PROCEDURES

A. Energize motor, verify proper operation of motor, drive system, and fan wheel.

B. Measure and record motor electrical values for voltage and amperage.

3.3 MOTOR ADJUSTMENT

A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.

3.4 PROTECTION

A. Remove and replace products or materials that are wet, moisture damaged, or mold damaged.

END OF SECTION 230513

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings

1. Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components.
2. Trapeze pipe hangers including product data for components.
3. Metal framing systems including product data for components.
4. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified structural professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anvil International, Inc.
2. B-Line Systems, Inc. (a division of Cooper Industries)
3. ERICO/Michigan Hanger Company
4. PHD Manufacturing, Inc

B. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped for hangers in contact with galvanized piping.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of steel or stainless steel in moist area.

C. Copper Pipe Hangers:

1. Nonmetallic Coatings: Plastic coating, jacket, or liner for hangers in contact with copper piping.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ERICO International Corporation.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
3. Rilco Manufacturing Co., Inc.

B. Description: 100 psig minimum, compressive-strength insulation insert encased in sheet metal shield.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hilti, Inc.
2. ITW Ramset/Red Head
3. MKT Fastening, LLC
4. Powers Fasteners.

B. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 ROOF EQUIPMENT SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Curbs Plus, inc.
2. Pate Company (The)
3. Roof Products, Inc.
4. Thybar Corporation

B. Equipment supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter.

C. Support Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

D. Material: Zinc-coated galvanized steel sheet, 0.052 inch thick.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

B. Do not suspend hangers from roof decks. Suspend from roof trusses, joists and joist girders only at panel points and at top chords unless otherwise indicated.

C. All piping hangers in exterior spaces, such as parking garages, exposure to high humidity, etc., or in interior swimming pool areas shall be galvanized.

D. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

E. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

G. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.

H. Use padded hangers for piping that is subject to scratching.

I. All mechanical equipment shall have concrete bases and/or structural steel supports and shall be provided by this contractor.

J. The use of pumps or other equipment as piping supports shall be prohibited. All such connectors and their supports shall be independently supported from the building structure and inspected and approved by the Engineer before bolting.

K. Piping connections to all equipment with moving parts shall be isolated with braided copper or stainless steel flexible links, which shall be selected to absorb the deflection on the isolating members.

L. Use thermal-hanger shield inserts for insulated piping and tubing.

M. Hangers: Provide adjustable, Steel Clevis Hangers (MSS Type 1) for suspension of noninsulated or insulated, stationary pipes.

N. Horizontal-Piping Clamps: Provide Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3) for suspension of pipes requiring clamp flexibility and up to 4 inches of insulation.

O. Vertical-Piping Clamps: Provide pre-insulated extension pipe or Riser Clamps for support of pipe risers.

P. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

Q. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Inserts:

   a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from structural concrete ceiling.

2. Clamps:

   a. C-Clamps (MSS Type 23): For structural shapes.
   b. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

3. Miscellaneous:

   a. Welded Beam Attachments (MSS Type 22): For attaching to bottom of steel beams if loads are considerable and rod sizes are large.
   b. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      1) Light (MSS Type 31): 750 lb.
      2) Medium (MSS Type 32): 1500 lb.
      3) Heavy (MSS Type 33): 3000 lb.

   c. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   d. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

R. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

S. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

T. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

U. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

V. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

W. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

X. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

Y. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

Z. Install lateral bracing with pipe hangers and supports to prevent swaying.

AA. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, expansion joints, strainers and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

BB. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

CC. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

DD. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation. Do not exceed pipe stresses allowed by manufacturer.
b. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
c. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
d. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shields:

   a. Install protective galvanized steel shields, MSS Type 40, on insulated piping smaller than 2-inch NPS. Shields shall span an arc of 180 degrees and shall be a minimum of 12-inches in length.
   b. Install thermal-hanger shield inserts on all insulated piping 2-inch NPS and larger.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

D. Concrete bases shall extend at least 4” beyond the bed or frame of the supported machine. Equipment bases shall have straight and finished sides and a 1”-45 degree chamfer at the top. Reinforcing steel bars (Type #4) shall be placed in a grid pattern in both directions of the base spaced at 12” on center.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Piping:

Piping Material	Pipe Size	Hanger Spacing (OC)
Steel	NPS 1-1/4” and smaller	8’-0”
Steel	NPS 1-1/2” to NPS 2”	10’-0”
Steel	NPS 2-1/2” and larger	12’-0”
Copper	1” and smaller	6’-0”
Copper	1-1/4” and larger	8’-0”

1. In addition to supported pipe information above, support piping at each change in direction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product indicated.

B. Shop Drawings

1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Samples

1. For color, letter style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. General: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Brady (W.H.) Co., Signmark Div.
2. Brimar.
3. Seton Name Plate Corp.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. For piping less than NPS 6, Provide full-band pipe markers, extending 360 degrees around pipe, fastened by one of the following:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe or insulation.
4. Taped to pipe or insulation with color-coded plasic adhesive tape, not less than ¾” wide; full circle at both ends of pipe marker, tape lapped 1-1/2”.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, pre-printed, self-adhesive plastic labels.

B. Letter Color: White.

C. Background Color: Blue, red, orange and green.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inches by 3/4 inch.

F. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.2 EQUIPMENT LABEL INSTALLATION

A. The contractor shall provide labeling for each piece of equipment above the ceiling. Labeling shall be on ceiling grid (not ceiling tile) below the equipment. The label shall match the equipment identification shown on the drawings sheet.

B. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Pumps, compressors, chillers, and similar motor-driven units.
2. Fans, blowers, primary balancing dampers, air blenders and mixing boxes.

C. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. General: Install pipe markers on each system of flow, provide type and temperature identification, and include arrows to show normal direction of flow:

1. Heating (200 degrees F) Supply Return

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

C. Pipe Label Color Schedule:

1. Refrigerant Piping:

   a. Background Color: White.
   b. Letter Color: Brown.

2. Air conditioning Condensate Piping

   a. Background Color: White.
   b. Letter Color: Green.

3.4 DUCT LABEL INSTALLATION

A. General: Identify air supply, return, exhaust, intake and relief ductwork with tags and arrows, showing ductwork service and direction of flow.

B. Install plastic-laminated, self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For supply air ducts.
2. Red: For return air ducts.
3. Orange: For outside air ducts
4. Green: For exhaust-, relief-, and mixed-air ducts.
5. ASME A13.1 Colors and Designs: For hazardous material exhaust.

C. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacings along exposed runs. Identification shall be applied only to new work.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Shop Drawings

1. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
2. Final Report: Upon verification and approval prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Divide the contents of the report into the below listed divisions: General Information and Summary, Air Systems.

B. Quality Control

1. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. AABC: "National Standards for Total System Balance".
2. ASHRAE: ASHRAE Handbook, Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

B. Agency Qualifications

1. The HVAC Contractor shall procure the services of an independent Balance and Testing Agency, approved by the Engineer, and a member of Associated Air Balance Council (AABC) or NEBB, which specializes in the balancing and testing of heating, ventilating, and air conditioning systems, to balance, adjust and test all air and water systems and equipment as herein specified.

C. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

D. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

2. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

    a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
    b. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

E. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing."

1.3 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

A. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.

B. Report deficiencies discovered before and during performance of the testing and balancing procedures. Observe and record system reactions to changes in conditions. Record default setpoints if different from indicated values.

3.2 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Air balance and testing shall not begin until the system has been completed and is in full working order. The Contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Cut insulation, ductwork and equipment casings for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

1. Patch insulation, ductwork, and housings, using materials identical to those removed.
2. Seal ducts and piping after testing. Test for leaks and repair if found.
3. Plug and seal equipment casings after testing. Test for leaks and repair if found.
4. Seal insulation to re-establish integrity of the vapor barrier.

B. Mark equipment settings, including damper control positions, fan speed control levers, potentiometers and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

C. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

D. Record external static pressure on a profile schematic for each piece of HVAC equipment.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Fan(s) shall be balanced so that VFD speed at 55 hz shall be equal to design air flow to allow for an increase in flow using the VFD.

B. Adjust fans to deliver total indicated airflows within the maximum allowable fan motor speed listed by fan manufacturer.

3.5 PROCEDURES FOR CONDENSING UNITS

A. Measure entering- and leaving-air temperatures.

B. Record fan and motor operating data.

3.6 FINAL TEST AND BALANCE REPORT

A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC technicians or test and balance engineers.

B. One copy of the final test and balance report shall be sent to the engineer of record. Provide five additional copies to the contractor.

3.7 REVERIFICATION

A. T&B Agency shall recheck all measurements and make adjustments as required to complete the balancing. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second verification.

3.8 ADDITIONAL TESTS

A. Seasonal Periods: If initial T&B procedures were not performed during near-peak conditions, the engineer of record may request a temperature recheck to further verify performance at near-peak conditions.

B. Duct Leakage Testing:

1. Witness the duct pressure testing performed by the mechanical/installing contractor.
2. Verify that proper test methods are used and that leakage rates are within specified tolerances.
3. Report any deficiencies observed.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
2. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

B. Shop Drawings

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
4. Detail application at linkages of control devices.
5. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, installed R-values and accessories.

PART 2 - PRODUCTS

2.1 GENERAL

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

B. Installed R-Values for insulation on ducts shall comply with local mechanical and energy code as required for indoor applications.

2.2 INSULATION MATERIALS

A. Manufacturers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corp..
b. Johns Manville.

c. Knauf Insulation.
d. Owens Corning.

B. Interior (indoor) ductwork insulation shall have a minimum installed thermal resistance value of R6 or code minimum, whichever higher.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, without facing and with vapor barrier Type II with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jackets.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. For duct and plenum applications, provide insulation without facing and with vapor barrier with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jacket.

E. Vapor Barrier Material for Ductwork: Paper-backed aluminum-foil, except as otherwise indicated; strength and permeability rating equivalent to factory-applied vapor barriers on adjoining ductwork insulation, where available; with following additional construction characteristics:

1. High Puncture Resistance: Low vapor transmission (for ducts in exposed, high traffic areas susceptible to damage: Mech. Rooms, etc.)
2. Moderate Puncture Resistance: Medium vapor transmission (for ducts in concealed areas).

2.3 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated and provided per the field-applied jacket manufacturer's recommendations.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Color: White.

2.4 FIELD APPLIED JACKET CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated

B. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. Duct lining thermal resistance value shall comply with external duct wrap requirements.

C. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert.

3.2 DUCT INSULATION SCHEDULE

A. All ductwork shall be insulated except:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.
7. Supply ductwork exposed in conditioned spaces. Supply ductwork in mechanical rooms, plenums, server rooms and electric equipment rooms shall be insulated.
8. Toilet exhaust, general exhaust and return ductwork in an insulated joist space, insulated attic space or exposed in conditioned spaces.

B. Ductwork penetrating building envelope

1. Insulate all ductwork penetrations at the building envelope. Insulate all interior ductwork from the envelope penetration back to ten feet minimum. Insulate all exterior ductwork from the envelope penetration to the terminus with 2” thick elastomeric insulation with aluminum jacket.

C. Grilles, Registers, and Diffusers:

1. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles & registers in all ceiling spaces.
2. All transfer air ducts shall be provided with acoustic lining unless otherwise noted on drawings.

3.3 PENETRATIONS

A. Insulation installation through assemblies: Provide insulation continuously through assembly penetrations.

1. For applications requiring only indoor insulation, terminate insulation beyond exterior surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
2. Seal penetrations to maintain assembly rating.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Pittsburgh Corning Corporation; Foamglass.
   b. Caltherm Insulation.
   c. Johns Manville.

2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I without slits for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armacell LLC; AP Armaflex.
b. Aeroflex USA.
c. K-Flex USA.

D. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000-Degree Pipe Insulation.
c. Owens Corning; Fiberglas Pipe Insulation.

E. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Thermokote V.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

E. ASJ and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Approved equal

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14,. Smooth finish, 0.016 inch thickness

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:
   1) Same material, finish, and thickness as jacket.
   2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.

f. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

B. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

C. Provide continuous insulation through hangers, straps and all other supporting members.

D. Provide aluminum jacketing around all piping and fittings that are exposed exterior to the building.

E. Provide protective metal shields and thermal hanger shield inserts at all supporting members to prevent compression of insulation.

F. Flexible Closed Cell Elastomeric Installation: Slide full sections of insulation onto pipe. Do not slit pipe to fit around piping. All edges shall be clean cut. Insulation shall be pushed onto pipe, never pulled. All seams and butt joints shall be adhered and sealed using adhesive equal to Armaflex 520 Adhesive.

G. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.2 PENETRATIONS

A. Insulation installation through assemblies: Provide insulation continuously through assembly penetrations.

1. For applications requiring only indoor insulation, terminate insulation beyond exterior surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
2. Seal penetrations to maintain assembly rating.
3. Extend jacket of outdoor insulation outside of building at least 2 inches beyond the exterior assembly penetration.
4. Seal jacket to flashing with flashing sealant
5. Seal penetrations with flashing sealant.

3.3 GENERAL PIPE INSULATION INSTALLATION

A. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Provide insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
3. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
4. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

B. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

C. Provide removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Provide same insulation jacket as adjoining pipe insulation.

2. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

D. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

E. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.4 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. Insulation shall flexible elastomeric be the following minimum thickness:

a. Less than NPS 1-1/2: 1 inch thick.
b. NPS 1-1/2 and greater: 1-1/2 inch thick.

2. For ductless split systems insulate refrigerant suction and liquid lines between evaporators and condensing units. Insulate each line separately.
3. For refrigeration suction lines, insulate between evaporators and compressors.

3.5 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

3.6 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. If more than one material is listed, selection from materials listed is Contractor's option.

B. Piping, Concealed:

1. None.

C. Piping, Exposed indoors:

1. PVC

D. Piping, Exposed in Mechanical Rooms, etc..:

1. PVC.

END OF SECTION 230719

SECTION 23 09 00.13 – STAND ALONE HVAC CONTROLS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data
   1. Provide manufacturer's data sheets on the DDC sensors, thermostats, pressure stats, humidistats, terminal control units, and protection devices.

B. Shop Drawings
   1. Provide separate diagrams for each system, including piping, motor starting and interlock wiring, push buttons, control wiring, interior electrical circuits of control instruments with terminal designations, control motors, colors of wires, locations of instruments and remote elements, and normal position of valves, dampers, relays and control points list.
   2. A detailed description of the operation of the control system including device designations shall accompany the drawings. Schedule of dampers including size, leakage, and flow characteristics and a schedule of valves including close-off and flow characteristics shall also be furnished for the entire project.
   3. Provide the actual physical proposed room thermostat/temperature sensor and guards, at the time of submittal review, to both the Engineer and Owner for approval.
   4. Complete field wiring diagram with terminals labeled as they will be marked on the equipment, including sensors, control and power wiring for each sensor.
   5. Floor plans locating DDC terminal control units coordinated with work of other trades.

C. Samples
   1. Submit all product samples to general contractor/construction manager for owner review. All samples shall be shipped to the job trailer for owner review. Provide operating instructions, input/output information, functionality and options descriptions with each sample.
   2. Provide (1) sample of a Thermostat.

D. Scope
   1. The HVAC controls systems shall be supplied and installed completely under this Contract. Components shall be mounted and wired by the HVAC contractor.
   2. The engineering, installation, calibration, programming, and checkout necessary for complete and fully operational systems, as specified hereafter, shall be provided by the HVAC contractor.
   3. The HVAC contractor shall provide low voltage power wiring as required for wiring each individual control component. Power wiring shall be located within the same room as the equipment or within 20 feet of the connection. Electrical contractor shall install line voltage (above 100 volts AC) wiring according to Division 26.

E. System Description
   1. Furnish all labor, materials, equipment, and service necessary for a complete and operating HVAC control systems, utilizing electronic interfaces and actuation devices, as shown on the drawings and as described herein.

2. HVAC control system to be completely DDC with electronic sensors and electronic actuation of valves and dampers.

F. Work by Others
1. The Electrical Sub-Contractor shall install conduit and connect power wiring. Power wiring and conduit shall be defined as follows:
   a. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
   b. Wiring of line voltage emergency power feeds to junction boxes in locations of temperature control panels.
   c. Power wiring to line voltage motors shown on Electrical Plans and specified in the Electrical Sections.
   d. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the HVAC Contractor.
   e. Conduit for routing temperature control wiring where shown on electrical plans.
   f. Raceways where shown on electrical plans which shall be utilized for temperature control wiring.

G. Related Work
1. Provide all line size and non-line size automatic valves and separable wells.
2. Provide all necessary piping connections, taps and wells required for flow, pressure or temperature devices.
3. Provide dampers, if so indicated, under Equipment Specifications.
4. Assemble multiple section dampers with required interconnecting linkages, shafts and brackets and extend the required number of shafts through the ducts for externally-mounted damper motors. Jack shafts will be assembled with sealed roller or ball bearings of stainless steel construction.
5. HVAC contractor shall coordinate and remain on site with the balancing contractor to operate the facility management system during balancing. The HVAC contractor shall manipulate the system as instructed by the balancing contractor. This shall include but not limited to changing damper positions, valve positions, fan speeds, pump speeds and set points as required to complete the balancing procedures.
6. The installation of motor starters that are not factory installed, thermal overload switches, and power wiring to motors, starters, thermal overload switches, contactors, and electric heating coils is specified in another Division. This Section includes installation of controls plus wiring for automatic controls, electric damper and valve operators, terminal control units, interlocks, starting circuits, and wiring to power consuming control devices.
7. Area smoke detectors are furnished, installed and wired under another Division. Duct smoke detectors shall be installed under this Division but furnished and wired into the fire alarm system under another Division. This Section includes wiring alarm signal relays, provided and installed under another Division.

1.2 INSTRUCTION OF OPERATING PERSONNEL

A. General:
1. Conduct formal instruction sessions for operating personnel.
2. Obtain direction from the Owner on which operating personnel shall be instructed in each system.

B. Training
   1. Provide 1 formal training session. Such training session shall include but not be limited to:
      a. Basic instruction
      b. Operation and use of advanced features
      c. Optimization and energy management features.
   2. The session shall be conducted by factory-trained personnel and be a minimum of four (4) four (4) hour days, for a total of 16 training hours. Provide materials and training for up to 3 operators per session to be designated by the Owner.
   3. Provide CD-ROM format recording of training sessions. CD shall include an easy to use index of training segments with extensive description for quick, easy references. CD segments shall be created on the owners actual installed system. CD segments shall be established for each independent task that is covered in the training to reduce the owner's review time.
   4. Obtain a receipt acknowledging completion of each item of instruction.

1.3 SEASONAL ADJUSTMENTS

A. Visit each Building during the first heating or cooling season approximately 6 months after the date of substantial completion to make repairs and adjustments to provide uniform conditions throughout. Each visit shall consist of a minimum of one (1) day. Schedule the visit for the heating cycle during the months of October through November, and for the cooling cycle during May through June.

B. During each visit:
   1. Check and calibrate temperature control devices and thermostats.
   2. Test and verify control sequences for proper operation for the season.
   3. Modify the system based on the owner's direction.
   4. Assist the owner in understanding and clearing any alarms.

C. Prepare and submit a report for each visit documenting conditions found and corrective action taken.

D. Have the Owner sign the report acknowledging the visit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide Automatic Temperature Control systems manufactured and installed by one of the following:
   1. From HVAC equipment manufacturer
   2. Invensys
   3. Honeywell
   4. Siemens
   5. Delta Controls
   6. Schneider TAC

7. Alerton

2.2 GENERAL

A. Provide a complete system of direct digital controls (DDC) and monitoring points as specified herein. The DDC system shall interface with the electric and electronic systems to provide control outputs and monitoring inputs to the DDC systems as specified in other Division 23 sections.

B. The HVAC controls system shall allow full user operation with a minimum of training. It shall have an English language display.

2.3 CONTROL UNITS GENERAL

A. Provide an adequate number of control units to achieve monitoring and control of all points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Provide a minimum of one controller for each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all points associated with individual control loops are assigned to the same DDC controller. If multiple controllers are furnished, the contractor must make sure that corresponding outputs and inputs are on the same controller. Extra controllers will be required to ensure that all control outputs are controlled by a controller that has the control inputs directly connected to it. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. When multiple controllers are used for controlling one system, the controllers shall be identical. To minimize the number of spare parts that the owner will need to stock in the future, the same part number controller shall be used for all major system applications (i.e. AHUs, heating water system, chilled water system, pump systems, etc.). All analog outputs shall be true AO (4-20mA or 0-10Vdc). Floating, pulse-width or phase-cut modulating outputs will not be acceptable for this project. Each of the following panel types shall meet the following requirements.

B. Controllers shall be suitable for the anticipated ambient conditions.
   1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non-condensing.
   2. Controllers used in conditioned ambient space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.

C. Serviceability: All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

D. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

E. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

F. Automatic staggered restart of field equipment after restoration of power and short cycle protection is required.

2.4 MISCELLANEOUS

A. Materials
1. All materials and equipment used shall be standard components, of regular manufacture for this application.
2. All systems and components shall have been thoroughly tested and proven in actual use.

B. Motor Operated Dampers
1. General:
a. Blades shall be 16 gauge minimum and 6 " wide maximum and frame shall be of welded channel iron. Dampers with both dimensions under 18" may have strap iron frames. Dampers over 48" wide shall be equipped with a jack shaft to provide sufficient force throughout the intended operating range.
b. Dampers shall be black enamel finish or galvanized, with nylon bearings.
c. Blade edge, tip and jamb seals shall be included for all dampers. Leakage through the damper shall not exceed 10 CFM per square foot at 4" w.g. (based on a 48" x 48" test sample).
d. Motor operated dampers shall be parallel blade for two-position control and opposed blade for proportional control applications.
e. All low voltage motor operated dampers throughout the project shall be wired by the HVAC Contractor. Refer to the fan and mechanical schedules, drawings, and control specifications for quantity of motor operated dampers.
2. Damper Actuators
a. Electronic damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range. All actuators operating in series or parallel to another actuator or in an open loop, such as minimum percentage outside air, shall be equipped with a positive positioning device. Provide spring return type actuators on outside air (close), return air (open), and relief air (close) dampers.
b. Actuators for all dampers and AHU and VAV valves shall be manufactured by Invensys (Duradrive), Siemens (OpenAir) or Belimo. The manufacturer must include a five year warranty from the manufactured date for the actuator.
3. Manufacturer:
a. Dampers shall be manufactured by Ruskin, Greenheck or Tamco.

C. Thermostats
1. The thermostat shall be located where shown on the drawings. Provide a thermostat with digital readout of temperature with integral room setpoint adjustment. The thermostat shall contain a push-button for override of unoccupied conditions, up and down arrows to scroll through attributes and enter key to make changes.
2. The thermostat display shall be capable of full programmability of the unit controller without the use of a portable editing device. The thermostat shall be capable of showing the unit controller time and day of week. The display shall be capable of displaying setpoints & temperatures in either 1-degree increments or 0.1-degree increments and space temperature an accuracy of +/– ½ degrees. The thermostat shall provide unoccupied override with cancel. The override time shall be user settable from 1 minute

up to 7 days. For 1 minute to 16 hours the user shall be able to select any one minute interval.

3. Thermostats shall be RTD or Thermistor type, providing a linear OHM per degree F characteristic change, and shall be housed as required for the application.
4. Temperature ranges shall be selected as required for the application and all sensors shall be +/-1 deg. F.

D. Airflow Monitoring Stations
1. General: Provide electronic airflow monitoring stations to measure and control airflow with separate air flow measuring device and separate damper for control.
2. Signal: Device shall provide a 4-20 mA signal for converting to exact airflow. Unit shall be calibrated to measure exact airflow through the entire range of values from 0 to 100% flow.
3. Probes: Provide multiple probes as required to measure airflow. Verify with air balance in field and adjust and add probes as required to maintain exact airflow measurement.
4. Sensors: Provide multiple sensors per probe as recommended by manufacturer according to dimensions. Provide on glass encapsulated self-heated thermistor and one glass encapsulated thermistor temperature sensor for each sensing point.
5. Support Struts and Support Bracket: Tubular aluminum extrusion.
6. Enclosure: Provide aluminum enclosure for indoor use and Nema 4 enclosure for outdoor use.
7. Airflow station shall be thermal dispersion technology or equivalent performance and equal to Ebtron GTx116-P for duct and plenum applications
8. Fan inlet measurement devices are not acceptable.
9. Manufacturer: Subject to compliance with requirements, provide airflow measuring stations of one of the following:
   a. Ebtron
   b. Kele
   c. Paragon Controls
   d. Ruskin Mfg. Co.
   e. Tek-Air Systems Inc.
   f. Ultratech Industries

PART 3 - EXECUTION

3.1 CONTROL DEVICES AND WIRING

A. Low Voltage Temperature Control Devices
1. Low voltage thermostats shall be furnished, installed and wired by the HVAC contractor.
2. The electrical contractor shall provide 4” square by 1-1/2” deep wall outlet boxes (with single-gang rings) for all thermostats/sensors. The electrical contractor shall provide one ¾” empty conduit from each thermostat/sensor location, turned out above accessible ceilings (in joist space or against overhead slab/deck).
3. The HVAC Contractor shall provide all other necessary conduit, raceway and wiring related work. Conduit shall be identified in ceiling cavity and shall be provided with sweep bends, bushings and drag line.
4. The HVAC Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

B. Line Voltage Temperature Control Devices
   1. The electrical contractor shall provide 4" square by 1-1/2" deep wall outlet boxes (with single-gang rings) for all thermostats.
   2. The electrical contractor shall provide line voltage power wiring, from thermostat outlet box to equipment that is to be controlled by the thermostat, in ¾" conduit.
   3. Provide with a contactor to shut fans and close valve through the DDC system.
   4. The HVAC Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

C. General Control Wiring Requirements and Installation Methods
   1. Except where specifically indicated otherwise herein or within Division 23 specifications, the HVAC Contractor shall provide all low voltage electrical work as required for all temperature control related wiring (i.e. conduit, raceway, outlet boxes, junction boxes, wiring, etc.) in accordance with Division 26 requirements. All conduit shall be 3/4" minimum.
   2. Coordinate all thermostat/sensor locations in field (case by case) with Architect, Owner and Electrical Contractor to ensure that they are placed in locations that will not interfere with furniture, equipment, artwork, wall-hung specialties, room finishes, etc. All thermostat/sensor wall locations indicated on HVAC drawings are schematic only and must be verified case-by-case prior to rough-in.
   3. All electrical work as described in this specification shall be per the latest edition of the National Electrical Code (NEC) and per applicable state and local codes. Refer to Division 26 specifications for required installation methods and follow Division 26 requirements as related to low voltage and communication technology system cables.
   4. Where "free-air" installation methods (either exposed above the ceilings, in bridle rings or in cable trays) are permitted under Division 26 above ceilings, provide plenum-rated cables wherever plenum ceilings (if any) exist and install as defined under Division 26. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electrical conduit regardless of what wiring methods are permitted under Division 26.
   5. Where cable trays or bridle rings are provided by the electrical contractor for low voltage cables, these raceways may be utilized for control wiring by this contractor (provide special color coded jackets, label cable jackets per Division 26 and group control wiring cables together). Provide conduit drops from cable tray/bridle ring paths to wall outlet boxes and equipment unless directed otherwise under Division 26.
   6. Regardless of permitted methods in Division 26, all cables/wiring installed concealed by gypsum board, masonry or other inaccessible materials in walls or above ceilings shall be installed in conduit, ¾" minimum.
   7. All conduit, bridle rings, raceway, outlet boxes, etc. necessary for complete operational installation of control wiring shall be provided (furnished and installed) by the temperature control contractor in strict compliance with Division 26 documents. Coordinate all work with all other applicable trades including the electrical contractor.
   8. Provide all required conduit work to and between equipment in a manner compliant with that described above (i.e. between VAV boxes, to boilers, starters, condensing units, etc. as applicable).
   9. Install control wiring without splices between terminal points, color-coded. Where a splice is required, install within junction box. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and per Division 26.

10. Install circuits over 25 volt with color-coded No. 12 wire in electrical metallic tubing, per Division 26. Install circuits under 25 volt with color-coded No. 18 wire with 0.031" high temperature (105 degrees F) plastic insulation on each conductor and plastic sheath over all. Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
11. All control cabling shall be labeled at both ends with descriptive information of control device.

3.2 OPERATING AMBIENTS

A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions of –40 degree F to +140 degree F.

B. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.

3.3 COMMISSIONING

A. Automatic Temperature Controls
1. Wiring and tubing shall be identified with the same numbers and symbols as used on the corrected, approved record diagrams.
2. Label control apparatus with nameplates or valve tags bearing the functional designations shown on approved control diagrams.

B. Operation and Maintenance Manuals
1. Submit on disk in electronic format using Adobe PDF version 7 or higher
   a. Include marking or tagging of specific models and options used on the project.
   b. All schedules shall be submitted in Microsoft Excel or comma delimited format.
   c. All drawings be submitted in AutoCAD DWG or DXF format.
2. Submit manuals 1 month before systems start-up and commissioning.
3. General Contents
   a. Title page with project name, contractor's and subcontractors' names, addresses and telephone numbers.
4. Index Sheet
   a. Manufacturers' operating and maintenance manuals, including parts lists for each piece of equipment and accessories requiring service or maintenance, the warranty period, and the name, address, and telephone number of the nearest sales and service organization for each item.
   b. Complete description of functions and operation of each piece of equipment including descriptions of how equipment operates in conjunction with automatic control systems, and instruction for cleaning, lubrication, and maintenance.
   c. Descriptive information:
      1) Function or service.
      2) Classification.
      3) Design capability.
      4) Performance characteristics.
      5) Principal components.
      6) Distribution arrangement.

7) Schematic diagram.
8) Control diagram.

d. Equipment data:
1) Materials of construction.
2) Parts designation.
3) Manufacturer and model number.
4) Size and rating.
5) Pressure, speed, and temperature limitations.

e. Inspection and maintenance information:
1) Inspection schedule and checklist.
2) Schedules and procedures for lubrication, replacement, adjustment, cleaning, painting, protection and testing.
3) Standard forms for compiling inspection and maintenance records.
4) Inspection during operation.
5) Adjustment and regulation.
6) Operational test procedures.
7) Detection of malfunction.
8) Precautions.
9) Troubleshooting.

f. Step-by-step procedure for starting, stopping, an operating each system:
1) Starting and stopping procedures.
2) Adjustment and regulation.
3) Seasonal changeover.
4) Seasonal shut down.
5) Seasonal start-up.
6) Logs and records.

g. Copies of inspection certificates provided by the city, county, state and insurance companies.

h. Approved start and completion dates of the guarantee period.

i. Valve schedules and diagrams.

j. Point to point document for all control and monitoring points.

C. HVAC

1. Control System

a. Control diagrams including electric and interlock wiring.

b. Final installed control software listings and flow charts. Listings shall include English comment lines documenting purpose of each group of executable statements and relationship to control sequence for ease of future troubleshooting and modification.

c. Record data base information.

d. Point identification and sensor characteristics.

e. As-built wiring diagrams.

f. Contents shall be type written.

D. DOCUMENTATION

1. Submit the following certificates, statements, receipts, and reports as specified herein:

a. Record drawings.

b. Submittals.

c. Operation and maintenance manuals.

d. Certification of controls calibration and testing.

e. Receipts for controls training.
f. Receipt acknowledging no controls failures during test period.

E. RECORD DRAWINGS
1. Record drawings shall include the manufacture and model number of equipment indicated in schedules on the Drawings.
2. Reproductions of design drawings shall not be used in the preparation of record drawings.
3. All record drawing information (drawings and cut sheets) shall be furnished in an electronic format.

3.4 MAINTENANCE

A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations.

3.5 EQUIPMENT START-UP AND CHECK-OUT

A. General
1. Verify readiness for start-up of each item of equipment on the basis of inspection.

B. Automatic Temperature Controls
1. The system manufacturer shall provide the services of control technicians at start-up to check-out the system, input data supplied by the Owner, and place the system in operation. Manufacture shall verify proper operation of each item in the sequences of operation, including hardware and software.
2. Check-out each system for control function through the entire sequence. Check actuator travel on dampers and valves for action and extent. Check calibration of instruments.
3. Verify that control dampers open and close completely.
4. Calculate and verify instrument setpoints.

C. Controls Acceptance Conditions
1. Calibration and testing: Calibrate equipment and verify operation before the system is placed on-line. Check each control point, within the system by making a comparison between the control command at the operator console and field-controlled device. HVAC control loops, interlocks, sequences, energy management programs, and alarms shall be tested and stable operation verified. Control loop parameters and tuning constants shall be adjusted to produce accurate, stable control system operation. Before obtaining permission to schedule the acceptance test, provide written certification that the installed complete system has been calibrated, tested and is ready to begin acceptance testing.
2. Acceptance test: Conduct final acceptance test, with the Owner on site, on the complete and total installed and operational automation system to demonstrate that it is functioning in accordance with requirements specified herein. Demonstrate the correct operation of monitored and controlled points as well as the operation and capabilities of sequences, reports, specialized control algorithms, diagnostics, and software.
3. Final system acceptance will be based on the following items:
a. Completion of the installation of hardware and software items. Demonstrate complete operation of the system, including hardware and software, with no

failures during a 14 consecutive day period. Obtain receipt from the Owner acknowledging no failures within the test period. Submit a daily log documenting failures.

b. Satisfactory completion of the record drawings, and operating and maintenance manuals.

c. Satisfactory completion of training programs.

3.6 ACCEPTANCE PROCEDURE

A. Upon completion of the calibration, contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation.

B. Contractor shall be responsible for generating all software and entering all database information as necessary to perform the sequence of control and specified software routines.

C. An acceptance test in the presence of the Owner's representative or engineer shall be performed.

END OF SECTION 23 09 00.13

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. Provide written sequences of operation for each controlled system and piece of equipment. Sequences shall be written in Contractor's own words and shall not be a repetition of the sequences contained herein.

1.2 GENERAL CONTROL REQUIREMENTS AND SEQUENCES

A. Electrical contractor shall provide all 120 Volt power wiring as required for temperature control panels, damper actuators and valve actuators, and transformers as required to low voltage. Electrical Contractor shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly.

B. This contractor shall be familiar with and responsible for wiring of all auxiliary equipment (control and power wiring), and controllers required under the mechanical Division 23. Equipment and controllers shall include but not be limited by the following items:

C. These additional general requirements shall also apply.

1. All fresh air intakes and relief/exhaust ducts or louvers, gravity roof ventilators, etc. shall have motor operated dampers. Dampers shall be low leak with blade and edge seals.

    a. All motor operated dampers shall be furnished and installed by the mechanical contractor, unless otherwise noted. All damper actuators shall be furnished and installed by the Mechanical Contractor, (unless damper and actuator are provided by equipment manufacturer). All low voltage damper actuators shall be wired by this contractor. All line voltage damper actuators shall be wired by the Electrical Contractor. This Contractor shall provide all necessary transformers, contactors, controls and wiring for interlocking equipment to motor operated dampers. Provide end switches as necessary for proper sequencing of damper operation and energizing of fan motor.

2. All Programmable Thermostats shall be programmed at startup based on a time of day schedule from the owner. The owner shall be trained on the how to change the setpoints and time of day of the programmable thermostat.
3. All control setpoints shall be adjustable through the equipment controller. Initial setpoints may be given in this section, but shall be adjusted in the field per actual field conditions or per the owner's recommendations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 REFER TO THE HVAC DRAWINGS FOR HVAC EQUIPMENT SEQUENCE OF OPERATIONS.

3.2 VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS

A. Fan Coil Units

1. Startup

   a. The unit shall operate on an occupied/unoccupied cycle as controlled from the control panel.

2. Supply Fan

   a. The supply fan shall run continuously, and modulate up and down based on a call for space heating or cooling.

3. Space Temperature Control

   a. Provide local wall mounted room temperature thermostat with digital display of room temperature and setpoint (+/- deg. F. adjustable) and override feature.

4. Minimum Outside Air Control (Decoupled Ventilation)

   a. During occupied mode the energy recovery unit shall energize and provide minimum outside air flow to the space.

5. Cooling Control

   a. Cooling shall be controlled to maintain space temperature setpoint. On a call for cooling the reversing valve shall move to the cooling position and modulate supply fan speed. On a further call for cooling the mechanical cooling shall be staged on.

6. Heating Control

   a. Heating shall be controlled to maintain space temperature setpoint. On a call for heating the reversing valve shall move to the heating position and modulate supply fan speed. On a further call for heating the mechanical heating shall be staged on.

7. Smoke Detector

   a. When the smoke detector is alarmed, the air handler shall fail safe with manual reset. Electrical contractor shall furnish, HVAC Contractor shall mount & Electrical contractor shall wire a UL listed photoelectric smoke detector per local code authority having jurisdiction.

8. Unoccupied Mode

a. During the unoccupied mode of operation, the FC shall go into night setback mode.

9. Night Setback/Shutdown

a. Night Setback is defined by the following: The heating is off and the mechanical cooling is off. The supply fan shall modulate in conjunction with either the heating or cooling system to maintain a night setback minimum/maximum space temperatures depending on the season.

10. Shutdown

a. At shutdown the FC shall go to fail safe position. Fail safe position is defined by the following: The supply fan is off, the outdoor air intake damper is closed, the heating is off and the mechanical cooling is off.

3.3 DUCTLESS SPLIT SYSTEM ACU

A. The unit shall operate on a 7-day/night schedule with three hour occupied and/or unoccupied override. The fan shall cycle in sequence with the heating/cooling coils to maintain space temperature setpoint.

B. Provide Low Ambient Controls on condensing unit for operation down to -20 degrees F.

3.4 DUCTLESS SPLIT SYSTEM ACU – DATA CLOSET

A. The unit shall operate to maintain space temperature set point. The fan shall cycle in sequence with the heating/cooling coils to maintain space temperature setpoint. On a call for cooling, the evaporator fan shall start and run continuously and mechanical cooling shall stage on. All a call for heating, the evaporator fan and mechanical cooling shall shut down.

B. Provide Low Ambient Controls on condensing unit for operation down to -20 degrees F.

3.5 CONDENSING UNITS

A. All safeties interlocks associated with the condensing unit shall be hard wired. Software interlocks are acceptable as secondary additional safeties.

B. Unit shall have self-contained controls by unit manufacturer. Provide Low Ambient Controls on condensing unit for operation down to -20 degrees F.

C. On a call for cooling, with all safety devices satisfied, the first stage compressor contactor and condenser fan contactor energize causing the compressor and condenser fan motor to operate (the indoor fan contactor shall be wired to start at the same time as the compressor). A liquid line solenoid valve will open when the first stage compressor starts.

D. On a further call for cooling, the second stage compressor contactor and condenser fan contactor energize causing the second stage compressor and condenser fan motor to operate. A liquid line solenoid valve will open when the second stage compressor starts.

E. As cooling demand decreases, the second stage compressor contactor and condenser fan contactor de-energize causing the second stage compressor and condenser fan motor to shut down. A corresponding liquid line solenoid valve will close when the second stage compressor is off preventing refrigerant migration back to the compressor during the off cycle.

3.6 EXHAUST FANS

A. General

1. Provide high limit pressure switch on the suction side of all constant volume fans greater than 3 HP to disable the fan upon exceeding static pressure setpoint. Provide manual reset.

B. Toilet Exhaust Fans (Timeclock)

1. Exhaust fans shall be tied to timeclock, which shall be furnished, installed and wired by electrical contractor. When activated, exhaust fan motor damper shall open and fan shall start.

END OF SECTION 230993

SECTION 232113.20 - AIR-CONDITIONING CONDENSATE PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

B. Shop Drawings

1. Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. DWV Copper Tubing: ASTM B 306, Type DWV.

B. Copper Fittings and unions: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco
b. Mueller
c. Elkhart Products

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.3 DIELECTRIC FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Nibco
2. Mueller
3. Elkhart Products
4. Watts Regulator Company

B. Dielectric Unions and Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Nibco
    b. Mueller
    c. Elkhart Products
    d. Watts Regulator Company

2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig minimum at 180 deg F.
    c. Union End Connections: Solder-joint copper alloy and threaded ferrous.
    d. Factory-fabricated, bolted, companion-flange assembly.
    e. Flange End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric Flange Insulating Kits:

1. Description:

    a. Non-conducting materials for field assembly of companion flanges.
    b. Pressure Rating: 150 psig.
    c. Gasket: Neoprene or phenolic.
    d. Bolt Sleeves: Phenolic or polyethylene.
    e. Washers: Phenolic with steel backing washers.

D. Dielectric Nipples:

1. Description:

    a. Standard: IAPMO PS 66
    b. Electroplated steel nipple. complying with ASTM F 1545.
    c. Pressure Rating: 300 psig at 225 deg F.
    d. End Connections: Male threaded.
    e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Condensate is to discharge indirectly into sanitary system as shown on plans. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping at a uniform grade of 0.2 percent downward in direction of flow.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

F. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

G. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

H. Install escutcheons for piping penetrations of walls, ceilings, and floors.

END OF SECTION 232113.20

SECTION 232123.13 - AIR CONDITIONING CONDENSATE PUMPS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of pump. Include certified performance data and rated capacities, operating characteristics, furnished specialties and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings

1. For each pump show pump layout and connections. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 AUTOMATIC CONDENSATE PUMP UNITS FOR BELOW CEILING APPLICATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Beckett Corporation.
2. Hartell Pumps Div.; Milton Roy Co.
3. Little Giant Pump Co.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

C. Provide factory mounted failsafe switch that opens upon failure of the condensate pump.

D. Capacities and Characteristics:

1. Up to 5 Tons connected condensate load

a. Storage Tank Capacity: 0.33 gallons

2.2 AUTOMATIC CONDENSATE PUMP UNITS FOR PLENUM APPLICATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hartell Pumps Div.; Milton Roy Co.
2. Little Giant Pump Co.

B. Description: Packaged units with corrosion-resistant pump, cast aluminum construction, dual voltage, auxiliary safety switch and automatic controls. Pumps shall be listed to UL Standard 2043, 3rd Edition “Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces” and provide a hard-wire electrical connection. Include factory- or field-installed check valve.

C. Provide factory mounted failsafe switch that opens upon failure of the condensate pump.

D. Capacities and Characteristics:

1. Storage Tank Capacity: 1 gallon

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

B. Install units for collecting condensate and extend to open drain.

3.2 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install check valve and ball valve on discharge side of pumps.

D. Provide control wiring to associated HVAC equipment so that upon failure of the condensate pump, the associated unit shall de-energize.

END OF SECTION 232123.13

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, filter dryers and strainers.

B. Shop Drawings

1. Show 1/4 inch equals 1 foot layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Check Valves:

1. Body: Ductile iron or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron or cast bronze.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

B. Service Valves:

1. Body: Bronze with bronze cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

C. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

D. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

E. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Bronze or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).

7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 450 psig.

F. Moisture/Liquid Indicators:

1. Body: Bronze.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

G. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Sized to meet tonnage of system
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

H. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. Retain first subparagraph below for liquid-line filter dryers.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Sized to meet tonnage of system
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

I. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump applications:

1. NPS 5/8 and Smaller: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 3/4 to NPS 1 and Smaller: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/4 to NPS 2: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Safety-Relief-Valve Discharge Piping:

1. NPS 5/8 and Smaller: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 3/4 to NPS 1 and Smaller: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/ to NPS 2: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install a full-sized, three-valve bypass around filter dryers.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

G. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

H. Install receivers sized to accommodate pump-down charge.

I. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Select system components with pressure rating equal to or greater than system operating pressure.

B. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

C. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

D. Install sleeve seals for piping penetrations of concrete walls and slabs.

E. Install escutcheons for piping penetrations of walls, ceilings, and floors.

F. Refrigerant piping shall be sized per equipment manufacturer’s recommendations including all necessary traps, double suction risers, etc, and pipe size increases based on actual layout, distance and unit sizing.

G. Provide bushings between copper piping and pipe supports to eliminate dissimilar metal condition.

H. Where outdoor units are mounted on grade, route refrigerant piping above grade and through outside wall and up within wall for extension to indoor unit.

I. Bleed dry nitrogen through refrigerant piping during brazing operations.

J. Provide locking-type tamper resistant caps on all refrigerant circuit access ports.

3.4 PIPE JOINT CONSTRUCTION

A. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

B. Steel pipe can be threaded, but threaded joints must be seal brazed.

C. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.
6. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
7. Factory- and shop-fabricated ducts and fittings.
8. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
9. Elevation of top of ducts.
10. Dimensions of main duct runs from building grid lines.
11. Fittings.
12. Reinforcement and spacing.
13. Seam and joint construction.
14. Penetrations through fire-rated and other partitions.
15. Equipment installation based on equipment being used on Project.
16. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
17. Hangers and supports, including methods for duct and building attachment and vibration isolation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal

Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dixie Sheetmetal
b. Eastern Sheetmetal of Cincinnati
c. Linx Industries.
d. Semco Mfg., Inc.
e. Hranec

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials

involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Fabricated ductwork shall comply with AMCA Standard 511 for air leakage.

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Exposed ductwork which is to be painted shall have paint grip applied.

D. Exposed Ductwork: Provide paint grip on all exposed ductwork that is required to be painted. Refer to architectural drawings for areas where duct is to be painted. Coordinate with all trades prior to installing paint grip.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation”

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

B. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

C. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

3.2 INSTALLATION OF DUCT LINER

A. General: Install duct liner in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

B. Size of ductwork shown on the drawings is free net area, outside dimension of ducts will need to be increased if lined duct is used.

C. The following ductwork shall be lined:

1. Return from open ceiling plenum return to HVAC unit.
2. Transfer Air ducts.

D. The following ductwork shall be lined with flexible duct liner:

1. Return ductwork in ducted return systems 10 feet downstream of HVAC unit.
2. Exhaust ductwork 10 feet upstream and downstream of fans.
3. Transfer air ducts.

E. The following ductwork shall be lined with rigid duct liner:

1. Return from open ceiling plenum return to HVAC unit.
2. Field or shop fabricated return air/outside air mixing plenums at HVAC units.

3.3 DUCT SEALING

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 PAINTING

A. All ductwork required to be painted shall be cleaned and oil-free. Mechanical Contractor shall prepare ductwork surfaces accordingly to accept primer and paint.

B. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.5 FIELD QUALITY CONTROL

A. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
e. Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

END OF SECTION 233113

SECTION 23 31 16.00 - NONMETAL DUCTS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data
   1. Fabric Duct

B. Shop Drawings
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevation of top of ducts.
   4. Dimensions of main duct runs from building grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Penetrations through fire-rated and other partitions.
   9. Equipment installation based on equipment being used on Project.
   10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

PART 2 - PRODUCTS

A.

2.2 FABRIC DUCT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. KE Fibertec
   2. DuctSox Corporation
   3. Qsox
   4. FabricAir

B. Warranty
   1. Manufacturer must provide a non prorated 10 year warranty on products supplied for the fabric portion of the system. Prorated warranties less than 10 years shall not be accepted.

C. Product Delivery, Storage, and Handling
   1. Deliver fabric in factory-fabricated cardboard type cartons containing ducts sealed in polyethylene protective bags. Identify, on outside of container, type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices. Store fabric duct systems in original cartons and protect

from weather and construction work traffic. Where possible, store indoors. When necessary to store outdoors, store above grade and enclose with waterproof wrapping.

D. Air Distribution Devices
   1. For application with 15’ throws / 16’ installation heights
      a. Provide a system with true nozzles. Ducts with slots mesh, reinforced holes or other openings, which do not discharge air perpendicular to the length of the duct shall not be acceptable.

E. General Construction
   1. Fabric duct shall be Round constructed of a permeable polyester, or a material of equivalent quality and duct holding capacity. Non permeable ducts will not be accepted
   2. 100% flame retardant and UL classified as an air distribution device in accordance with the flammability requirements of NFPA90A
   3. Orifices shall be mounted in fabric at angles specified by engineer or recommended by manufacturer.
   4. Weight 8.6 oz/yd2
   5. Fabric shall be heat set and permeability stabilized, and not shrink more than 0.5% when washed in accordance with manufacturer’s maintenance instructions.
   6. Provide system in sections optimized to fit in commercial washing machine (less than 20 ft sections for diameters larger than 28”), connected by zippers. Zippers must provide closure completely around the circumference, with min 1” overlap to prevent leakage.
   7. Systems should be designed from .25” W.G. minimum in order to keep ducts fully inflated. Maximum 3.0”, however, most applications should be designed around .5” W.G.

F. Mounting Hardware
   1. Provide single row mounting hardware system. Mounting rails to be of extruded aluminum 10 mil anodized. Single length of rail shall be as shown on drawings, or as required to mount fabric ducts. Factory shall cut rails to required length, providing sections for field assembly and installation. Rails shall suspend fabric ducts by means of an integral flexible cord. Which slides into the extruded aluminum rails. Rails shall be suspended by means of a snap-on rod assembly (or cable dropper if preferred). Ducts greater than 36” diameter shall be suspended by dual track, with integral cords sewn into the duct at 3:00 and 9:00.
   2. Provide single cable suspension mounting hardware system. Single horizontal nylon coated cable at 12 0’clock position, ducts to have clips to snap on to cable. Intermittent vertical supports of nylon coated cable shall be supplied by manufacturer. Two row cable suspension shall be provided for diameters over 26”. Provide duct inlet clamp, constructed of stainless steel. Ducts shall be freely suspended from mounting hardware to prevent contact with piping, light fixture, etc.
   3. Provide three point mounting system. Mounting rail to be extruded aluminum 10 mil anodized. Single length of rail shall be at the 12 o’clock position with intermittent duct support at 10 abd 2 from an aluminum support bracket which clips to the safe track. Similar cable based systems shall not be accepted as an equal. Factory shall cut rails to required length, providing sections for filed assembly and installation. Rail shall suspend fabric ducts by means of an integral flexible cord, which slides into the extruded aluminum rails. Rails shall be suspended by means of a snap-on suspension piece, which is in turn mounted to the ceiling, by an adjustable, galvanized 3’ threaded rod assembly (or cable dropper if preferred). Ducts greater than 48” diameter shall be suspended by dual Safe Track, with integral cords sewn into the duct at 3:00 and 9:00.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches.

B. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

C. Fabric Duct
   1. Provide soft-start on air handler supplying fabric duct (VFD, etc.) with ramp-up time (minimum 30 seconds) adjusted as necessary to prevent objectionable start-up noise and poping.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of nonmetal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 23 33 00.00 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
   3. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   5. Provide drainage and cleanup for wash-down procedures.
   6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

END OF SECTION 23 31 16.00

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product.

B. Shop Drawings

1. For duct accessories. Include plans, elevations, sections, details and attachments to other work.
2. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include special fittings, manual volume damper installations, motor operated damper installations, fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

1.2 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.

B. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 3000 fpm.

D. Maximum System Pressure: 3-inch wg.

E. Frame: Hat-shaped, 0.063-inch- thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, 0.050-inch- thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:

1. Material: Aluminum.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Bearings: Bearings shall be dustproof ball type for low pressure operation.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Screen Mounting: Front mounted in sleeve.

    a. Sleeve Thickness: 20 gage minimum.
    b. Sleeve Length: 6 inches minimum.

4. Screen Mounting: Inlet.
5. Screen Material: Aluminum.

6. Screen Type: Bird.
7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Nailor Industries Inc.
   b. Ruskin Company.
   c. Greenheck Fan Corporation.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. For units less than 36" wide or 12" high:

   a. Frame shall be 22 gage galvanized steel.
   b. Blade shall be single skin, 22 gage galvanized steel with center "V" groove for reinforcement.
   c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
   d. Axles shall be 3/8" square shaft positively locked into damper blade.

5. For units over 36" wide and 12" high :

   a. Frame shall be 18 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement.
   b. Blades shall be single skin 18 gage galvanized steel with three longitudinal grooves for reinforcement.
   c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
   d. Axles shall be hexagonal positively locked into damper blade.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 MOTOR OPERATED DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

B. All louvers, gravity roof ventilators, etc. shall have motor operated dampers. Dampers shall be low leak with blade and edge seals.

C. All dampers shall be furnished and installed by the mechanical contractor. All low voltage motorized damper actuators shall be furnished, installed and wired by the TCC, unless damper & actuator are provided by equipment manufacturer. All line voltage motor operated damper actuators shall be furnished and installed by the TCC and wired by the EC. TCC shall provide all necessary transformers, contactors, controls and wiring for interlocking equipment to motor operated dampers. Frames shall be 5" x 1" x 0.081" minimum thickness, 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall be reinforced with two die formed internal braces and machine staked for maximum rigidity.

D. Blades shall be airfoil type galvanized steel with integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket which enables air pressure from either direction to assist in blade to blade seal off. Blades seals shall be mechanically locked in extruded blade slots, yet shall be easily replaceable in field. Adhesive or clip-on type blade seals are not acceptable.

E. Bearings shall be non-corrosive molded synthetic. Axles shall be square to provide positive locking connection to blades and linkage. Round axles are not acceptable. Linkage shall be concealed in frame.

F. All dampers shall be tested in accordance with AMCA 500 and shall be rated AMCA Class 1A for 3.5 cfm/sf at 1” wg pressure for all sizes 24” wide and above.

G. Dampers shall be parallel blade for 2-position control and opposed blade for modulating control.

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Fire Rating: 1-1/2 and/or 3 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve:

1. Each fire damper shall include a steel sleeve and retaining angles furnished by the damper manufacturer to ensure appropriate installation.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Eastern Sheetmetal.
3. Nexus PDQ; Division of Shilco Holdings Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aero Dyne.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen Manufacturing.
5. METALAIRE, Inc.

6. SEMCO Incorporated.
7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flexmaster U.S.A., Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Ruskin.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Continuous hinge and two sash locks.
c. Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.Factory set at 3.0- to 8.0-inch wg.
3. Doors close when pressures are within set-point range.
4. Hinge: Continuous piano.
5. Latches: Cam.
6. Seal: Neoprene or foam rubber.
7. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.10 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with local ASHRAE/IESNA 90.1 requirements.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install motor operated dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. These dampers, whether shown or the drawings or not, shall be installed at no additional cost to the Owner. Consult with Testing, Adjusting, and Balancing Agency prior to ductwork installation to establish damper locations

1. Install steel dampers in steel ducts.

E. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, motor operated dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream

from dampers and inward operation for access doors installed downstream from dampers.

7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.
9. Control devices requiring inspection.
10. Elsewhere as indicated.

F. Install access doors with swing against duct static pressure.

G. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

H. Install flexible connectors to connect ducts to equipment. The use of flexible connectors as a means of duct transitions is prohibited.

I. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

J. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

K. Maximum length of flexible branch duct shall not exceed five feet and only be used at air devices.

L. Do not install flexible duct above inaccessible ceilings.

M. Install duct test holes where required for testing and balancing purposes.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.
7. Roof curbs.
8. Fan speed controllers.

B. Shop Drawings

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: For power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Engineering & Mfg. Corp.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. Twin City Fan Companies.

B. Project Altitude: Base fan-performance ratings on actual Project site elevations.

C. Operating Limits: Classify according to AMCA 99.

D. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 80,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 80,000 hours.

E. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 80,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 80,000 hours.

F. Roof Curbs: Provide factory fabricated insulated roof curb by the same manufacturer as the equipment. Roof curb to be insulated.

2.2 CEILING-MOUNTED VENTILATORS

A. Housing: Steel, lined with acoustical insulation.

B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

C. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

D. Outlet Damper: Exhaust fan shall have back draft damper at outlet of exhaust.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Isolation: Rubber-in-shear vibration isolators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide high static pressure switch in the ductwork downstream of exhaust fans greater than 3 hp. Fan shall shutdown upon detection of static pressure in excess of 2” wc.. Provide manual reset.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS AND LOUVERS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of product indicated, include the following.
2. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
3. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 DIFFUSERS AND REGISTERS DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anemostat Products; a Mestek company.
2. Carnes.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Price Industries.
6. Titus.
7. Tuttle & Bailey.
8. Warren Technologies.

2.2 LOUVERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airolite Co.
2. Air Balance
3. American Warming & Ventilating, Inc.
4. Arrow United Industries, Inc.
5. Carnes
6. Greenheck
7. Louvers & Dampers, Inc.
8. Penn Ventilator Co., Inc.
9. Ruskin Mfg. Co.
10. Dowco.
11. United Enertech
12. Nailor

B. Performance: Provide louvers that have maximum free area, and minimum pressure drop for each type as listed in manufacturer's current data, complying with louver schedule.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate, which will contain each type of louver.

D. Plenum: Provide insulated plenum on all louvers, same dimension as louver with minimum depth of 12”. Provide transition to plenum for proper air distribution. Seal around all plenums to wall to prevent air leakage.

E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

B. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

END OF SECTION 233713

SECTION 236213 - AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings

1. For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
2. Wiring Diagrams: For power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Commercial HVAC Systems.
2. Lennox International Inc.
3. Bryant
4. McQuay International

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Refrigerant: R-407C or R-410A. Provide lockable covers on refrigerant fill ports.

D. Condenser coils and any piping exposed to the elements shall be Heresite coated.

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

A. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and 2 pole contactor.
2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
3. Accumulator (4 and 5 ton units only): Suction tube.

B. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and bronze service valves with service ports.

1. Condenser coils and any piping exposed to the elements shall be Heresite coated.

C. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

D. Accessories:

1. Compressor start assist kit.
2. Crankcase heater.
3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
4. Electronic programmable thermostat
5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
6. Filter-dryer.
7. Head pressure control to modulate condenser fan motor speed.
8. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
9. Liquid-line solenoid.
10. Low-Ambient Controller: Cycles condenser fan to permit cooling operation down to -20 deg F with time-delay relay to bypass low-pressure switch.
11. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
12. Low-voltage control transformer
13. PE mounting base.
14. Precharged and insulated suction and liquid tubing.
15. Provide subcooler and accumulator.
16. Thermostatic expansion valve.
17. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

E. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing. Unit shall be complete with bronze service valves, fittings, and gage ports on exterior of casing.

2.3 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

A. Compressor: reciprocating hermetic-type compressor, 1,750 RPM, designed for air-cooled condensing, complete with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports. Capacity shall be controlled through cylinder unloading. Additional features include:

1. Crankcase heater in well within crankcase;
2. Capacity steps as scheduled, or greater number;
3. Compressor of same manufacturer as condensing unit

B. Compressor: Hermetic or semihermetic rotary screw compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: Variable-frequency controller.

C. Condenser Coil: Condenser coil shall be seamless copper tubing mechanically bonded to heavy-duty, configurated aluminum fins, with separate and independent refrigeration circuit for each compressor. Units shall include liquid accumulator and subcooling circuit, and backseating liquid line service access valve. Condenser coils shall be factory-tested at 450 psig, vacuum dehydrate, and filled with a holding charge of nitrogen.

D. Condenser Fans: Propeller-type vertical discharge; direct drive. Include the following:

1. Permanently lubricated ball bearing condenser fan motors;
2. Separate motor for each condenser fan;
3. Constant speed condenser fan motors;
4. Each fan assembly shall be dynamically and statically balanced.
5. Head pressure control, thermostatic expansion valve, evaporator freeze stat, compressor start assist kit for low ambient conditions down to –20 degrees F.
6. Provide subcooler and accumulator

E. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.
5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

F. Accessories:

1. Electronic programmable thermostat to control compressor and condenser unit and evaporator fan.
2. Low-Ambient Controller: Cycles condenser fan to permit cooling operation down to 0 deg F with time-delay relay to bypass low-pressure switch.
3. Gage Panel: Package with refrigerant circuit suction and discharge gages.
4. Part-winding-start timing relay, circuit breakers, and contactors.

5. Reversing valve.

G. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Factory-installed metal grilles, for protection of condenser coil during shipping, installation, and operation
5. Condenser coil hail guard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install compressor and condenser units on 4” thick concrete base. Concrete base shall be 4” larger on each side than unit.

B. Where units and refrigerant piping are located a distance of 10 feet or more from the building, provide 4” PVC sleeve and raceway with full radius elbows for refrigerant piping.

C. Vibration Isolation: Mount compressor and condenser units on rubber pads.

END OF SECTION 236213

SECTION 237434 – PACKAGED VARIABLE RERIGERANT VOLUME DEDICATED OUTDOOR AIR UNIT

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 package rooftop heating and cooling units of the following:
   1. Rooftop Heat Pump Dedicated Outdoor Air Units

B. Related Sections:
   1. Section 23 05 03 “Submittals for HVAC”.

1.3 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:
   1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
   2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   3. Wiring Diagrams: Power, signal, and control wiring.

C. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

E. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting details 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. Size and location of rooftop replacement-air unit mounting rails and anchor points and methods for anchoring units to roof curb.
   2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

F. Startup service reports.

G. Operation and Maintenance Data: Submit maintenance data and parts list for each rooftop units, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop replacement-air units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. 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.

C. Codes and Standards:
1. AGA Compliance: Shall bear the AGA label
2. ARI Compliance
3. UL Compliance
4. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".
5. Rooftop units shall be listed by UL and have UL label as a unit.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
1. Retain subparagraph below for units with fuel-fired furnaces.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than ten years from date of Substantial Completion.

B. Warranty on Energy Recovery Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, heat exchanger with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

C. Warranty Period: 5 years from date of owner acceptance.

PART 2 - PRODUCTS

2.1 INDOOR / OUTDOOR HEAT PUMP UNITS

A. Unit Casing: Exterior panels are of 20-gauge steel, cleaned, phosphatized and coated with resin primer and baked enamel finish. Units shall be double wall construction with injected foam panels with an R value of 7 BTU/(hr °F ft^2). Interior liner shall be 24 gauge galvanized steel

B. Access doors provide access to unit controls, filters, indoor coil, supply air fans, economizer/outside air dampers, and return air dampers. Inside air section is completely insulated with fireproof, permanent, odorless, glass fiber material. All removable panels and access doors have neoprene gaskets to prevent leakage. The unit base pan is insulated with polyurethane foam insulation.

C. Unit floor panel shall be double wall construction with 18 gauge galvanized steel flooring surface and 22 gauge galvanized steel underliner.

D. Knockouts are provided for utility and control connections. Drain connections are provided to accommodate indoor and outdoor coil water runoff. Lifting lugs are provided as an integral part of the unit.

E. Heat Recovery Refrigerant Regulator:
   1. The heat recovery terminal section is designed specifically for use with variable refrigerant volume heat recovery system components and are to be pipe to the remote mounted heat pump VRF condensing unit.
   2. The heat recovery refrigerant tegulator shall be factory assembled, wired, and piped. . The selector box shall be integral to the unit and must be mounted inside of the unit control cabinet.
   3. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. Solenoid valves shall not be acceptable. Refrigerant connections must be of the braze type.
   4. The heat recovery terminal box shall not require any condensate drainage connection.
   5. The heat recovery refrigerant regulator shall modulate refrigerant flow to the DX coil to maintain heat and cooling leaving air temperature set points. The refrigerant regulator shall also modulate flow to the hot gas reheat coil for dehumidification control.

F. Refrigerant Circuit: All units have electronic expansion devices to provide proper refrigerant flow control in both heating mode and cooling mode. Heating and cooling modes shall be controlled by the DDC controller and the heat recovery refrigerant regulator. Refrigerant flow, temperature, and pressure shall be modulated by the heat recovery refrigerant regulator.

G. Evaporator Coil: Indoor coils are 3/8-inch OD seamless copper tubing mechanically bonded to aluminum fins and are factory pressure and leak tested.

H. Hot Gas Reheat Coil- For single zone or 100% outdoor air applications, provide modulating hot gas reheat on the lead refrigerant circuit. Hot gas reheat shall include two modulating valves, dehumidification control, field installed space humidistat, DX coil LAT sensor, reheat coil LAT sensor, all associated piping and be automatically operated by the units microprocessor control. The heat recovery refrigerant regulator shall modulate the selector box expansion valves to maintain leaving dew point from the DX coil. Leaving dry bulb reheat temperature control

accuracy shall be +/- 0.5 degrees F. An aluminum micro-channel reheat coil shall be used to minimize refrigerant charge.

I. Condensate Pan: Provide IAQ stainless steel, double sloping drain pain. Provide high condensate switch in primary condensate pan to de-energize unit upon detection of high condensate levels.

J. Evaporator Fan: Direct Drive plenum type fans are standard. Fan and motor bearings are permanently lubricated. Motor shall be ECM type and shall be inherently variable speed. Fan drive components are mounted on rubber-in-shear isolators to reduce noise and vibration.
   1. Frequency Drive: Provide factory mounted and wired frequency drive and Nema rated disconnect switch. (Verify VFD can be factory mounted & wired)

K. Enthalpy Wheel
   1. Shall be an integral part of the unit and shall incorporate a rotary wheel in an insulated cassette frame complete with seals and drive motor. Bolt on enthalpy wheel sections shall not be acceptable.
   2. The enthalpy wheel shall be coated with silica gel desiccant, by proprietary process, without the use of binders or adhesive which may plug the desiccant aperture. The substrate shall be lightweight polymer and shall not require additional coating for application in marine or coastal environments. Nominal finished thickness of coated material shall be 6 to 8 mils. Coated segment shall be cleanable. The desiccant shall not dissolve or deliquesce in the presence of water or high humidity.
   3. The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry arrangement providing laminar flow and minimum pressure drop to efficiency ratio. The wheel shall be provided with removable segments for cleaning and maintenance. The layers shall be effectively captured in aluminum and stainless steel segment frames providing a rigid and self-supporting matrix.
   4. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segment in place. Segments shall be removable without the use of tools and facilitate maintenance and cleaning. Wheel bearing shall be selected to provide an L-10 life in excess of 30 years. Rim shall be continuous rolled stainless steel to form an even concentric rim. Wheel drive motor shall be provided, mounted in the cassette frame and supplied with AMP universal Mate N-Lok connector. Wheel drive motor shall be a UL recognized component.
   5. The enthalpy wheel shall include a variable speed defrost system. The variable speed defrost system shall control the speed of the wheel to prevent frost. The variable speed defrost system shall include supply and return air sensors.
   6. The wheel shall also vary speeds to control capacity during low load situations so as not to create a false heating or cooling load on the system.
   7. The enthalpy wheel cassette shall be UL recognized for electrical and fire safety. The manufacturer’s rating shall be in accordance with ASHRAE Standard 84 method of test, and Standard 1060 ARI Rating shall certify performance.

L. Filters: Provide a 2” MERV 8 filter for the outdoor air and exhaust air streams. Provide a 4” MERV 13 filter for the supply air stream.

M. Controls
   1. Control Wiring: Factory wire connection for controls' power supply.
   2. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

3. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

4. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

5. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

6. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
7. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display dedicated outdoor air unit status and alarms.
   a. ASHRAE 135 BACnet communication interface with building management system shall enable building management system operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at dedicated outdoor air unit control panel shall be available through building management system.
8. Unit -Mounted Status Panel:
9. DOAS unit shall be tied together to a **single graphical user interface** provided by the unit manufacturer. The shall be tied into the variable refrigerant system and graphically displayed by the VRF central controller. All wiring shall be provided by the Mechanical Contractor. Provide unit in a central location as indicated on the drawings. The controller shall provide the following:
   a. Scheduling: The controls shall be able to schedule to unit for a full year.
   b. Cooling/Off/Heating Controls: Control mode and setpoint.
   c. Unit operation changeover control: Return air temperature.
   d. Cooling and heating change-over temperature with deadband.
   e. Cooling/Heating discharge air temperature setpoint adjustment.
   f. Status/Alarms
   g. Filter dirty.
   h. Fan operating.
   i. Cooling operating.
   j. Heating operating.
   k. Smoke alarm.
   l. General alarm.
10. Digital Numeric Display:
    a. Return air temperature

b. Discharge air temperature
c. Outdoor air temperature
d. Space Temperature
e. Space C02 Levels
f. Outdoor enthalpy, high/low
g. Condenser fan speed
h. Inverter compressor speed
i. Dirty filter indication
j. Airflow verification
k. Cooling status
l. Control temperature (Changeover)
m. Cooling status/capacity
n. Economizer Operation
o. Unit status
p. All time schedules
q. Active alarms w/time and date
r. Previous alarms with time and date
s. Supply fan and exhaust fan speed
t. System operating hours

11. Morning warm-up or night setback status.
    a. Wall-mounted humidistat or sensor with the following features:
    b. Concealed set point.
    c. Concealed indication.

N. Electrical
1. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
2. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection
3. Wiring: Numbered and color-coded to match wiring diagram.
4. Wiring Location: Install factory wiring outside an enclosure in a raceway.
5. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
    a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
    b. NEMA KS 1, heavy-duty, nonfusible switch.
    c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
6. Factory-Mounted, Overcurrent-Protection Service: For each motor.
7. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
8. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

O. Outside Air Options
1. Provide an Airflow Measuring Station for measuring Outside Air. Station shall be factory installed. AMS shall be interfaced with unit's DDC controls and the airflow setpoint shall be adjustable through the controls interface. Unit shall have measuring device separate from damper. Provide all necessary controllers, transformers and calibration required to interface damper with unit's controls.
2. VAV Powered Relief Option – Provide factory installed 0-100% fully modulating exhaust fan with variable frequency drive or ECM motor, including relief damper section with mist

eliminator and building pressurization control. Dampers shall open to relieve positive pressure within the building. Exhaust fan shall be sized for 100% of supply air CFM.

P. Provide the following Accessories:
   1. Electric Supplemental Heaters: Slide-in heater module mounts in unit discharge air passage.
      a. Suppplmental heat shall be engaged once the unit cannot meet the heating mode leaving air setpoint. The unit heat pump coil and supplemental heat shall work in series to meet the leaving air temperature set point with the first stage of heat being the heat pump coil with the supplemental being the second stage. Once the heat pump function can no longer add heat into the sytem, the supplemental heat will provide all the heat input into the system
      b. Electric heat to be SCR controlled and fully modulating. Staged electric heat control will not be acceptable.
   2. Horizontal Discharge - Provide units where required with horizontal supply and return duct connections. Provide all necessary curbs and modifications as required for horizontal discharge option.
   3. CO2 Demand control ventilation sensor and controls for single zone applications.

Q. Manufacturer: Subject to compliance with requirements, provide rooftop units of one of the following:
   1. Reznor
   2. Venmar
   3. Daikin Applied
   4. AnnexAire
   5. Unison

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. The rooftop unit(s) shall be installed a minimum of 10’-0” from any roof edge regardless of location indicated on plans, unless a screen wall or railing is installed per the local building code. See the architectural plans for coordination.

C. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirement of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

F. Start-up rooftop units, in accordance with manufacturer's start-up instructions. Test controls and demonstration compliance with requirements. Replace damaged or malfunctioning controls and equipment.

G. Condensate Piping: Provide Type L copper condensate piping with trap.

3.3 TRAINING OF OWNER'S PERSONNEL:

A. Provide services of manufacturer's technical representative for 1-half day to instruct Owner's personnel in operation and maintenance of rooftop units.

B. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

3.4 SPARE PARTS:

A. General: Furnish to Owner, with receipt, the following spare parts for each rooftop unit:
   1. 1 set filters for each unit.

3.5 DEMONSTRATION:

A. Start-Up Services:
   1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Operating and Maintenance Training:
   1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division One.
   2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

END OF SECTION 237433

SECTION 238126 - VARIABLE REFRIGERANT FLOW SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

B. Samples

1. Submit all product samples to general contractor/construction manager for owner review. All samples shall be shipped to the job trailer for owner review. Provide operating instructions, input/output information, functionality and options descriptions with each sample.
2. Provide (1) sample of a Thermostat.

1.2 EXTRA MATERIALS

A. General: Furnish to Owner, with receipt, the following spare parts for AC unit:

1. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trane/Mitsubishi
2. Mitsubishi
3. Daikin

2.2 OUTDOOR CONDENSING UNITS

A. General

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
3. Each outdoor system shall be able to support the connection of up to 56 indoor units dependent on the model of the outdoor unit.

4. The sound pressure level standard shall be 64 dBA or lower as measured at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
5. The unit shall incorporate an auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge. As additional refrigerant is added to the system, the system shall calculate how much additional refrigerant is required to be added to the system.
6. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
7. Oil management:

    a. The system shall have high pressure oil return to ensure a consistent film of oil on all moving compressor parts.
    b. The system shall be provided with an oil separator designed to extract oil from the oil/refrigerant gas stream leaving the compressor and return the extracted oil to the compressor oil sump.
    c. Provide an oil level sensor in the compressor to provide direct oil level sensing.

8. The outdoor unit shall be capable at the following operating ambient air conditions:

    a. Cooling: 4°F DB to 122°F DB with low ambient kit
    b. Heating: -10°F DB to 61°F WB
    c. Cooling based synchronous: 14°F DB to 81°F DB
    d. Heating based synchronous: 14°F DB to 61°F DB
    e. Manufacturers that cannot provide heating operation at -10°F dry bulb shall provide supplemental electric heat or additional low ambient heating components in the condensing unit to allow for operation down to -10°F dry bulb. All additional engineering, electrical and installation costs shall be by the unit manufacturer.

9. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode. Reverse cycle (cooling mode) defrost during heating operation shall not be permitted due to the potential reduction in space temperature. Manufacturers that cannot provide heat while in defrost mode shall provide supplemental electric heat equal to the unit full load heating output. All additional engineering, electrical, and installation costs shall be by the unit manufacturer.

B. Unit Cabinet

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full acce4ss to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

C. Fans

1. Outdoor fans shall be direct-drive propeller type, and shall discharge air vertically. Fans shall below air through the outdoor coil.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory

set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.

3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.
6.
7.

Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

D. Compressor

1. All compressors shall be inverter driven.
2. The inverter scroll compressors shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. The capacity control range shall be 4% to 100%.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system
7. Compressor assembly shall be installed on spring or rubber vibration isolators and shall have internal spring isolation.
8. In the event of compressor failure for multiple compressor units, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
9. For multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of equalized run time, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

E. Outdoor Coil

1. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency

performance. The heat exchanger on the condensing units shall be manufactured from seamless copper tube with internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

F. Refrigeration Safeties

1. The following safety devices shall be included on the condensing unit;

   a. High pressure switch.
   b. Control circuit fuses.
   c. Crankcase heaters.
   d. Fusible plug.
   e. High pressure switch.
   f. Overload relay.
   g. Inverter overload protector.
   h. Thermal protectors for compressor and fan motors.
   i. Over current protection for the inverter.
   j. Anti-recycling timers.

G. Electrical Requirements

1. Unit electrical power shall be a single point connection.
2. Unit control voltage to the indoor-fan coil shall be 16 volt DC
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.
5. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire.

2.3 HEAT RECOVERY TERMINAL BOXES

A. General

1. The heat recovery terminal boxes are designed specifically for use with variable refrigerant volume heat recovery system components.
2. Selector boxes shall be factory assembled, wired, and piped. Branch controllers must be run tested at the factory. Selector boxes must be mounted indoors.

B. Unit Cabinet

1. Units shall have a galvanized steel plate casing. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator. The cabinet shall contain a heat exchanger shall be tube in tube type constructed from ACR copper. Cabinet insulation shall be sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene. Nominal sound pressure levels shall be 44 dBA or lower as measured at 5 feet.

C. Refrigerant Valves

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. Refrigerant connections must be of the braze type.
2. The heat recovery terminal boxes can have up to six ports of independent heating/cooling operation. All ports shall be isolated with full port isolation valves.

2.4 INDOOR FAN COIL UNITS

A. Wall Mounted Units

1. General

   a. The indoor unit shall be a wall mounted fan coil unit, operable with refrigerant R-410A, completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The local controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
   b. A mildew-proof, polystyrene air filter and condensate drain pan shall be included as standard equipment. The indoor units sound pressure shall range from 32 dB(A) to 38 dB(A) at low speed measured at 3.3 feet below and from the unit.

2. Unit Cabinet

   a. The cabinet shall be space saving and shall be located into the ceiling. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation. Fresh air intake shall be possible by way of a fresh intake kit. A branch duct knockout shall exist for branch ducting supply air.
   b. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting brackets shall be provided.

3. Fans

   a. Fan shall be tangential direct-drive blower type with air intake a t the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
   b. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.

4. Coil

   a. Coil shall be a minimum 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Maximum fin spacing shall be 15 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan

shall have internal trap and auxiliary drip pan under coil header. Provide condensate switch in the primary condensate pan that will shut down the unit upon detection of high condensate.

5. Motors

a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

6. High Water Alarm

a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

7. Controls

a. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 64F to 84F.
b. Provide hard wired programmable local controller and a return air sensor for each unit.
c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.

8. Filters

a. Unit shall have filter track with factory-supplied cleanable filters.

9. Accessories (Field Installed)

a. Condensate Pump
1) The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft. (3/4 ton unit) or 3 to 25 ft. (1-2 ton units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.

B. Ceiling Suspended Units

1. General

a. Indoor, direct-expansion, ceiling-suspended fan coil. Fan coil shall be shipped complete with cooling coil, fan, fan motor, piping connectors, electrical controls, solid-state electromechanical control system, and ceiling mounted brackets.

2. Unit Cabinet

a. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting brackets shall be provided.

3. Fans

a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high and low settings. Automatic motor-driven vertical air sweep shall be provided.

4. Coils

a. Coil shall be a minimum 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Maximum fin spacing shall be 15 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.

5. Motors

a. Motors shall be permanently lubricated with inherent overload protection. Fan motor shall be 3-speed.

6. Controls

a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
b. Provide hard wired programmable local controller and a return air sensor for each unit.
c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.

7. Filters

a. Unit shall have filter track with factory-supplied cleanable filters.

8. High Water Alarm

a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

9. Accessories (Field Installed)

a. Condensate Pump
1) The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft. (3/4 ton unit) or 3 to 25 ft. (1-2 ton units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.

C. In-Ceiling Cassette Units

1. General

a. The indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Unit shall include a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

2. Unit Cabinet

a. Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall have filter tracks and cleanable filters which shall be accessible from below with a 1/4 turn fastener.
b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation. Fresh air intake shall be possible by way of a fresh intake kit. A branch duct knockout shall exist for branch ducting supply air.

3. Fan

a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected. Air louvers shall be adjustable for 2, 3, or 4-way discharge.

4. Coil

a. Coil shall be a 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 17 fins per inch. A drip pan under the coil shall have a factory-installed condensate pump (minimum 21 inches of lift) and drain connection for hose attachment to remove condensate.

5. Motors

a. Motor shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.

6. Controls

a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
b. Provide hard wired programmable local controller and a return air sensor for each unit.
c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.

7. Operating Characteristics

   a. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled.

8. High Water Alarm

   a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

D. Concealed Ceiling Ducted Units

1. General

   a. Indoor unit shall be a ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation within a conditioned space. It shall have a front discharge air duct collar and filtered back or bottom return air. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. Included as standard equipment, a long-life filter that is mold resistant and a condensate drain pan. Units 4-tons or less shall be equipped with a condensate pump that pumps to 18" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 48 dB(A) at low speed 5 feet below the suction grille.

2. Unit Cabinet

   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings. The exterior of the unit shall be 18 gauge galvanized steel. The interior of the cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

3. Filter

   a. Provide a 2” MERV 13 high efficiency air filter for each medium static unit. For low pressure units, provide a washable long-life filter with mildew proof resin.

4. Fan

   a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high, medium, and low settings. The fan motor shall be thermally protected.

5. Coil

   a. Coil shall be a minimum 3-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Fin spacing shall no greater than 14 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. A condensate pump with a 9-13/16” lift shall be located below the coil in the condensate pan with a built in safety alarm.

6. Mixing Box

a. Provide mixing boxes of physical size to match basic unit, and include equal-sized flanged openings capable of handling full air flow. Arrange openings as indicated on drawing sheets. Provide dual action parallel dampers for return air with sealing edges, arranged to operate automatically with one set of linkage. Provide parallel blade damper for outside air directed towards the return air stream for reduced stratification. Provide dampers of balanced construction, rotating in sintered bronze or nylon bearings.

7. Motors

a. Motor shall be totally enclosed and permanently lubricated with inherent protection. Fan motor shall be 3-speed.

8. Controls

a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
b. Provide hard wired programmable local controller and a return air sensor for each unit.
c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.

9. Operating Characteristics

a. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled.

10. High Water Alarm

a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

E. Floor Mounted Console Units

1. General

a. Indoor unit shall be a floor console fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation within a conditioned space. It shall have a top discharge air grill and filtered bottom return air. Cabinet shall be finished ivory white casing. Concealed units will not have a unit cabinet. The cabinets can be mounted on the floor with refrigerant and condensate lines directed downward or affixed to the wall with horizontal refrigerant and condensate knockouts. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. A mold-resistant, resin net air filter shall be included as standard equipment. The indoor units sound pressure shall range from 35 dB(A) to 40 dB(A) at high speed measured at 5 feet away and 5 feet high.

2. Unit Cabinet

a. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. The cabinet shall be affixed to a factory supplied wall mounting template and

located in the conditioned space. The cabinet interior shall be constructed with sound absorbing fiberglass urethane foam insulation. Maintenance access shall be a minimum of ¾ inch in the rear, 4 inches on the right and left sides.

3. Fans

   a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available. The airflow rate shall be available in high and low settings. Automatic motor-driven vertical air sweep shall be provided.

4. Coils

   a. Coil shall be a minimum 3-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. Maximum fin spacing shall be 17 fins per inch. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.

5. Motors

   a. Motors shall be permanently lubricated with inherent overload protection. Fan motor shall be 3-speed.

6. Controls

   a. Controls shall consist of a solid-state electromechanical control system which shall control space temperature and determine optimum fan speed. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
   b. Provide hard wired programmable local controller and a return air sensor for each unit.
   c. Controls shall be 24 volt, and shall be easily operated by the user from a wall-mounted control unit.

7. Filters

   a. Unit shall have filter track with factory-supplied cleanable filters.

8. High Water Alarm

   a. Provide sensor in cooling drain pan that will shut down the indoor unit on high condensate levels.

9. Accessories (Field Installed)

   a. Condensate Pump
      1) The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft. (3/4 ton unit) or 3 to 25 ft. (1-2 ton units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.

2.5 CONTROLS

A. Physical Characteristics:

1. General: The control system shall be a neutral color plastic material. Each control may have a Liquid Crystal Display (LCD.

B. Electrical Characteristics:

1. Wiring: Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the branch selector box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit. The wire shall be a non-shielded, 2-core sheathed vinyl cord or cable, size AWG18-2.

C. Controller Characteristics:

1. Local Remote Controller

   a. The Local Remote Controller shall be mounted into a standard 2” x 4” junction box.
   b. Unit Display
      1) The Local Remote Controller shall be approximately 4.75” x 4.75” in size with a backlit 2.75” x 1.75” LCD display. Display information shall be selectable from English, French, or Spanish.
      2) Provide a backlit LCD display with contrast adjustment and auto off after 30 seconds.
      3) The controller shall display Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F. Detailed display will reflect room temperature (60-90°F range in one degree increments). Display of temperature information shall be configurable for Fahrenheit or Celsius.
      4) On/Off status shall be displayed with an LED.
      5) Error codes will be displayed in the event of system abnormality/error with a two digit code.
      6) The following system temperatures can be displayed to assist service personnel in troubleshooting:
         a) Return air temperature
         b) Liquid line temperature
         c) Gas line temperature
         d) Discharge air temperature (if available on the unit)
         e) Remote temperature sensor temperature
         f) Indoor temperature setpoint

2. Operation

   a. The unit shall be capable of controlling a group of up to 16 indoor units. The following operation groups shall be controlled:
      1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
      2) Independent cooling and heating setpoints in the occupied mode
      3) Independent cooling setup and heating setback
      4) Fan speed
      5) Airflow direction

6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
7) Lock out key settings
8) Indoor unit group assignment

3. Program Functions

a. Controller shall support schedule settings with selectable weekly pattern options.
1) Seven day week
2) Weekday + weekend
3) Weekday + Saturday + Sunday
4) Independently settable cooling and/or heating setpoints when unit is on (occupied).
5) Setup cooling and heating setback setpoints when unit is off (unoccupied)
6) A maximum of 5 operations can be schedulable per day
7) Time setting in 1-minute increments

b. The Controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
1) Changeover to cooling mode shall occur at cooling setpoint + 1ºF.
2) Changeover to heating mode shall occur at heating setpoint - 1ºF.

c. The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
2) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.

d. The space temperature shall be capable of being sensed at the local controller, the return air temperature sensor mounted in the unit, or a remote temperature sensor.

D. Multi-Zone Controller – Centralized Remote

1. General

a. The centralized remote controller shall provide control for all indoor units. It shall be capable of controlling a maximum or 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The centralized remote controller shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.
b. The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals of the outdoor unit. The centralized remote controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).
c. The centralized remote controller can be used in conjunction with BACnet, and Lonworks interfaces to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together.

Manual addressing is required of each indoor unit group associated with the centralized remote controller.

d. The centralized remote controller shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the internet or Local Area Network (LAN).

e. Optional software functions shall be available so that facility staff can securely log into each centralized remote controller via the PC's web browser to support monitoring, scheduling, error email, and general user functions. Additional optional software functions of Tenant Billing, and HTTP Interface shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license key from the manufacturer.

2. Mounting

a. The centralized remote controller shall be mounted on the wall or into a recessed fixing box.

3. Display Features

a. The centralized remote controller shall be approximately a 10" LCD display. Display information shall be selectable from English, French, Italian, German, or Spanish.

b. Featured backlit LCD with contrast adjustment and auto off after 30 minutes (default) is adjustable between 1 to 60 minutes.

c. Area and Group configuration
   1) Area contains one (1) or more Area(s) or Group(s)
   2) A Group may be an indoor unit, DI, DO point that has a network address.

d. An Area is a tiered group where management points (indoor unit, digital input/output and analog input groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels. Area configuration shall classify levels of monitoring and control for each management point.

e. The Controller shall display Date (mm/dd/yyyy or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).

f. The Controller shall adjust for daylight savings time (DST) automatically.

g. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.

h. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Set Schedule/Setback/Auto-changeover, Filter, and Screen Lock.

i. The controller shall display the temperature setpoint in one degree increments with a range of 60^0F - 90^0F. Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.

j. Display shall reflect room temperature 0^0F - 176^0F range in one degree increment.
   1) Display of room temperature information shall be configurable for Fahrenheit or Celsius.

k. The system setting mode shall be used to configure options and display information for each Zone or Group.

l. Zone configuration shall display Setpoint Range Limitation, Setback Temperature setting, and Auto-changeover for each Zone.

m. Floor plan layout: Capable of displaying site floor plan as the background for visual navigation. Indoor unit, DIII-NET DI and DO, and External DI, DO, and AI icons with operational status can be placed on the floor layout. Up to 4 status

points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode). Digital input and output icons will display On/Off status. Analog input icons will display analog value. The system shall have the ability to create up to 60 floor layout sections.

n. Indoor units shall be capable of being displayed by Zone or Group.
   1) Zones configuration via the centralized remote controller shall consist of a single indoor unit group or a collection of indoor unit groups blocked together for control and monitoring purposes.
   2) Groups shall consist of 1 to 16 indoor units daisy chained together via the remote control wiring to the indoor unit terminal block for control and monitoring purposes.
   3) Groups and Zones may be assigned names (ex. Office 101, Lobby, North Hallway, etc…)

o. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon.
   1) System errors are generated when the centralized remote control system with other VRV controls systems combined or power proportional distribution calculation errors occur. The centralized remote control system shall display the error with a red triangle placed on the lower task bar. Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon. Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon. Communication errors between the centralized remote control system and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon. Error history shall be available for viewing for up to 500,000 errors/abnormality event.

4. Basic Operation:

a. Capable of controlling Zone(s) or Group(s) of up to 64 indoor unit groups (128 indoor units).
b. Controller shall control the following group operations.
   1) On/Off
   2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)
   3) Independent Cooling and Heating setpoints in the occupied mode
      a) Cooling setpoint shall be maintained higher than or equal to the heating setpoint
      b) Adjustable minimum setpoint differential 0 - 7^{0}F between cooling and heating setpoint
      c) Selectable single setpoint mode
   4) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 40 - 95^{0}F.
      a) Setup and Setback setpoints shall be set outside of the occupied setpoint range.
      b) The recovery differential shall be 4^{0}F (default) and adjustable between 2 – 10^{0}F.
      c) Settings shall be applied based upon the Zone configurations.
   5) Fan Speed
      a) Up to 3 speeds (dependent upon indoor unit type).
   6) Airflow direction
      a) 5 fixed positions or swing position.

7) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Zone configurations.
8) Remote controller permit/prohibit of On/Off, Mode, and Setpoint.

c. Capable of providing battery backup power for up to 2 years in total time for the clock. All settings shall be stored in non-volatile memory.

5. Programmability

a. Controller shall support weekly schedule settings.
1) Selectable weekly patterns
a) 7-day
b) Weekday + weekend
c) Weekday + Saturday + Sunday
2) The schedule shall support unit On/Off.
3) 100 independent schedules configurable with up to 20 events settable for each schedule.
a) Each scheduled event shall specify time and target Zone or Group
b) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) Setpoint, Setback (Heating) Setpoint, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, and Timed Override Enable.
c) Independently settable Cooling and Heating setpoints when unit is on (occupied).
d) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied) by Zone.
e) Time setting in 1-minute increments.
f) A 2 hour override shall be provided for use enabling indoor unit operation during the unoccupied period.
4) A maximum of 40 exception days can be schedule on the yearly schedule.
a) Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions.
b) Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September).

b. The controller shall support auto-changeover
1) Auto-change shall provide Individual, Fixed, and Averaging changeover methods for both Heat Pump and Heat Recovery systems based upon the Zone configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
2) Individual method (recommended for Heat Recovery Systems)
a) Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the Zone.
b) Changeover affects individual indoor unit group in the Zone.
3) Fixed method
a) Changeover evaluated by room temperature and setpoints of the representative unit (first registered unit) in the Zone.
b) Changeover affects all indoor unit groups in the Zone.
4) Average method
a) Changeover evaluated by the average of all indoor unit group's room temperatures and setpoints in the Zone.

b) Changeover affects all indoor unit groups in the Zone.

5) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.

6) Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint, and the room temperature is greater than or equal to the average of the cooling and heating setpoints + 2.7^0F.

7) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint, and the room temperature is less than or equal to the average of the cooling and heating setpoints - 2.7^0F.

8) One hour guard timer
   a) Upon changeover, guard timer will prevent another changeover during this period.
   b) Guard timer is ignored by a change of setpoint manually from either centralized remote controller, local remote controller or by schedule.
   c) 60 minutes as default, configurable to 15, 30, or 90 minutes.

9) Third party devices
   a) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc…) to automatically control groups or zones corresponding to the change of the operation states or the On/Off states of any group.
   b) Requires digital input/output unit.
   c) On/Off based monitoring and control of equipment.
   d) Manual or scheduled operation of equipment.
   e) Operation based upon interlock with VRV indoor unit group(s).
   f) Monitor equipment error/alarm status.

10) Controller shall support force shutdown of associated indoor unit groups.

6. Auxiliary Inputs and Outputs

   a. Provide analog card with a minimum of four inputs and four outputs for auxiliary control and monitoring of the following:
      1) Electric Phase Loss
      2) Space Pressure

7. Software

   a. Licensed per option, per centralized remote controller shall be required. All PCs shall be field supplied.
      1) Web/Email software
         a) Each centralized remote controller shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (128 indoor unit groups with the addition of an expansion module) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 3 email addresses).
      2) Power Proportional Distribution (PPD)
         a) The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the outdoor unit(s) divided among the associated indoor units. This software is used in conjunction with the centralized remote controller and a Watt Hour Meter (WHM). A maximum of 3

Watt Hour Meters can be connected to the centralized remote controller.

b) The Power Proportional Distribution results data can be saved to a PCMCIA card, or on a PC with the use of the web option software. Data is saved in the CSV format. Results can be stored up to 12 months.

3) HTTP Interface

a) This option shall be capable of creating a software interface between the VRV Controls Network and Home Automation control systems.

8. Auxiliary Inputs and Outputs

a. Provide analog card with a minimum of four inputs and four outputs for auxiliary control and monitoring of the following:

1) Electric Phase Loss
2) Space Pressure

PART 3 - EXECUTION

3.1 PRE-INSTALLATION

A. At the time of the equipment submittal, a VRF piping diagram shall be provided from the manufacturer to the mechanical contractor for review. Mechanical contractor shall maintain a copy of the piping diagram at the project site.

B. The mechanical contractor shall update the VRF piping diagram with any field changes such as re-routing, shortening, lengthening or changing the diameter of a pipe segment, adding or eliminating elbows and/or fittings, resizing adding or eliminating indoor units, changing mounting heights or moving the location of a device or fitting during installation. Such changes shall be communicated by the mechanical contractor to the manufacturer for review and comment.

C. The manufacturer upon receipt of those changes shall enter them into the manufacturer's piping program. If the piping program indicates that the deviations do not meet the programs criteria for proper system piping, the manufacturer's representative shall inform the Mechanical Contractor of any associated problems and resolution for those problems. The mechanical contractor shall correct piping, at the cost to the Mechanical Contractor, to eliminate piping problems.

3.2 INSTALLATION:

A. Support: Install exterior units on grade on 4" thick concrete pad.

B. Support: Install exterior units on roof on equipment rail with flashing to roof. Provide rail type and flashing per roofing manufacturer requirements.

C. The condensing units shall be installed a minimum of 10'-0" from any roof edge regardless of location indicated on plans, unless a screen wall or railing is installed per the local building code. See the architectural plans for coordination.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

F. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1" deeper than fan pressure in inches of water.

G. Provide locking-type tamper-resistant caps on all refrigerant circuit access ports.

3.3 START UP AND COMMISSIONING

A. The unit manufacturer will be responsible for the start-up, programming, and commissioning of the entire variable refrigerant volume system. This will include coordinating the interface requirements and system points with the temperature controls contractor. Manufacturer shall test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. As part of the Pre-Startup Check List, the Mechanical Contractor shall confirm all piping change updates. The Manufacturer’s Representative shall update the Piping Program to an “As-Built” program. Proper refrigerant charge shall be calculated and communicated to the Commissioning/Startup Technician along with the As-Built piping program.

C. System shall be leak checked, evacuated and charged by the mechanical contractor.

D. System shall be programmed and started by a Manufacturer’s Trained/Certified Commissioning/Startup Technician.

E. After successful Startup/Commissioning a Commissioning/Startup report and As-Built Refrigerant Piping diagram shall be submitted to Owners Representative.

F. Manufacturer’s Representative make a minimum of 1 (or as many as necessary jobsite visits) to inspect systems and answer installation questions.

END OF SECTION 238126

SECTION 238129 - DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1.2 EXTRA MATERIALS

A. General: Furnish to Owner, with receipt, the following spare parts for AC unit:

1. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Subject to compliance with requirements, provide ductless split system air conditioning units of one of the following manufacturers:

1. Carrier
2. Mitsubishi
3. Sanyo
4. LG
5. Daikin
6. Samsung

2.2 OUTDOOR CONDENSING UNITS

A. General

1. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of HFC refrigerant, and special features required prior to field start-up.

B. Unit Cabinet

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full acce4ss to the compressor, fan, and control components.
3. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

C. Fans

1. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall below air through the outdoor coil.
2. Outdoor fan motors shall be totally-enclosed, single-phase motors with Class B insulation and permanently-lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.
3. Shaft shall have inherent corrosion resistance.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Outdoor fan openings shall be equipped with PVC coated protection grille over fan and coil.

D. Compressor

1. Compressor shall be fully hermetic reciprocating or scroll type.
2. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from overtemperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.
3. Motor shall be NEMA rated Class F, suitable for operation in a refrigerant atmosphere.
4. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
5. Compressor assembly shall be installed on rubber vibration isolators and shall have internal spring isolation.
6. Compressors shall be single-phase or 3-phase a specified on the contract drawings.

E. Outdoor Coil

1. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed.

F. Refrigeration Components

1. Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.

G. Controls and Safeties

1. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:

H. Controls

1. Time delay restart to prevent compressor reverse rotation on signal-phase scroll compressors.
2. Automatic restart on power failure.
3. Safety lockout if any outdoor unit safety is open.
4. A time delay control sequence provided through the fan coil board, thermostat, or controller.
5. High-pressure and liquid line low-pressure switches.
6. Automatic outdoor fan motor protection.

7. Start capacitor and relay (single phase units without scroll compressors).

I. Safeties

1. System diagnostics.
2. Compressor motor current and temperature overload protection
3. High pressure relief.
4. Outdoor fan failure protection.

J. Electrical Requirements

1. Unit electrical power shall be a single point connection.
2. Unit control voltage to the indoor-fan coil shall be 24 volt
3. All power and control wiring must be installed per NEC and all local building codes.
4. High and low voltage terminal block connections.

K. Special Features (Field Installed)

1. Low-Ambient Kit

   a. Control shall regulate fan-motor cycles in response to saturated condensing pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100 F +/- 10 F with outdoor temperatures to -20F. Installation of kit shall not require changing the outdoor-fan motor.

2. Liquid Solenoid Valve

   a. This electronically operated shutoff valve shall close and opening response to compressor operation. The valve should be used with all long-lines applications (over 100 ft.).

3. Winter Start Control

   a. Field supplied and installed winter start control shall permit start-up for cooling operation under low-load conditions and at low-ambient temperatures by bypassing the low-pressure switch for a 3-minute delay period.

4. Crankcase Heater (units with scroll compressors only).

   a. Unit shall be shipped with a clamp-on compressor oil sump heater.

L. Low Ambient Control: Provide head pressure control, designed to operate at temperatures down to 0 deg. F (-18 deg. C).

1. The outdoor unit shall be capable of providing full heating or cooling at the following operating ambient air conditions:

   a. Cooling: 4°F DB to 122°F DB with low ambient kit
   b. Heating: -10°F DB to 61°F WB

2. Manufacturers that cannot provide heating operation at -10°F dry bulb shall provide supplemental electric heat or additional low ambient heating components in the

condensing unit to allow for operation down to -10°F dry bulb. All additional engineering, electrical and installation costs shall be by the unit manufacturer.

2.3 HIGH WALL UNITS

A. General

1. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating (heat pump systems only) coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware.

B. Unit Cabinet

1. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

C. Fans

1. Fan shall be tangential direct-drive blower type with air intake a t the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
2. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.

D. Coil

1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
2. Condensate Pan: Provide IAQ galvanized steel, double sloping drain pain. Provide high condensate in primary condensate pan to de-energize unit upon detection of high condensate levels.

E. Motors

1. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

F. Controls

1. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 64F to 84F. The unit shall have the following functions as a minimum.

    a. Provide hard wired wall thermostat secured to wall. (remote control stats are not acceptable).
    b. An automatic restart after power failure at the same operating conditions as at failure.

c. A timer function to provide a minimum 24-hour timer cycle for system Auto. Start/Stop.
d. Temperature-sensing controls shall sense return air temperature. Indoor air high discharge temperature shutdown shall be provided.
e. Indoor coil freeze protection.
f. Wireless infrared remote control to enter set points and operating conditions.
g. Auto Stop features shall have integral setback control.
h. Automatic airsweep control to provide on or off activation of airsweep louvers.
i. Dehumidification mode shall provide increased latent removal capability by modulating fan speed and set point temperature.
j. Fan only operation shall provide room air circulation when no cooling is required.
k. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
l. Fan speed control shall be user-selectable: high, medium, low or microprocessor automatic operation during all operating modes.
m. A time delay shall prevent compressor restart in less than 3 minutes.

G. Filters

1. Unit shall have filter track with factory-supplied cleanable filters.

H. Electrical Requirements

1. Unit shall operate on 115 volt, 208 volt, or 230 volt, 60 Hz power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.

I. Operating Characteristics

1. The unit shall be matched with an outdoor unit. The combination of the outdoor unit and the indoor fan coil unit shall be sized as scheduled
2. The system shall have a minimum listed SEER (seasonal energy efficiency ratio) of 10.0 at ARI conditions.
3. Outdoor unit shall be rated at low decibels at ARI conditions.

J. Refrigerant Lines

1. The 009 and 012 units shall have rotatable refrigerant lines for penetration through the wall using flare connections. All units shall have flare connections and a 90-degree suction elbow shall be provided for rear connection.

K. Special Features (Field Installed)

1. Condensate Pump

a. The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft (3/4 ton unit) or 3 to 25 ft (1-2 ton units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.

2. Electronic Programmable Thermostat

   a. Provide hard-wired wall thermostat secured to wall. (remote control stats are not acceptable).
   b. Thermostat shall be commercial grade and shall provide 7-day, 4-event scheduling. Integral subbase shall be included. Thermostat shall also provide 3-speed fan switchover capability, air sweep auto changeover, and shall not require a battery to retain memory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support: Install exterior units on grade on 4" thick concrete pad.

B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

C. Drain Piping: Connect unit drain to nearest indirect waste connection. Provide trap at drain pan; construct at least 1" deeper than fan pressure in inches of water.

D. Provide locking-type tamper-resistant caps on all refrigerant circuit access ports.

END OF SECTION 238129

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Plans, elevations, sections, and details.
3. Location and size of each field connection.
4. Details of anchorages and attachments to structure and to supported equipment.
5. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
6. Location and arrangement of integral controls.
7. Wiring Diagrams: Power, signal, and control wiring.

1.2 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. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Airtherm; a Mestek Company.
2. McQuay International.
3. Modine
4. Rittling
5. Marlo

B. Description: An assembly including casing, coil, fan, and motor in vertical discharge configuration with adjustable discharge louvers.

C. Cabinet: Removable panels for maintenance access to controls.

D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and - tested propeller unit heater before shipping.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

G. General Coil Requirements: Test and rate propeller unit heater coils according to ASHRAE 33.

H. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

I. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

J. Fan Motor Type: Permanently lubricated, multispeed.

K. Control Devices:

1. Unit-mounted, fan-speed switch.
2. Unit-mounted thermostat.

2.2 WALL AND CEILING HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.
5. Marley Electric Heating; a division of Marley Engineered Products.
6. QMark Electric Heating; a division of Marley Engineered Products.
7. Airtherm
8. McQuay
9. Modine
10. Rittling
11. Raypack
12. Raywall

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:

1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated, multispeed.

G. Controls: Unit-mounted thermostat.

H. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof.

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints.

D. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers spring hangers spring hangers with vertical-limit stop.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

END OF SECTION 238239

SECTION 260100 - OPERATION AND MAINTENANCE OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Closeout

1. Operation and Maintenance Manual: For equipment and systems to include in operation and maintenance manuals.

B. Shop Drawings

1. As-Built Drawings: For recording installed conditions that deviate from design documents.

1.2 OPERATION AND MAINTENANCE MANUAL

A. The contents of operating and maintenance manual shall include the following:

1. Project Information Cover: Title of Project; Name and address of Owner, Design Professionals, Contractor of Record and Subcontractor; System name and specification references.
2. Index: Contents of the manual.
3. Warranty Statements: Furnish a warranty statement for each system, reiterating the terms of warranty identified within the Contract Documents, and identifying how the Owner is to obtain warranty service. Clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 1-year parts and labor). Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion. Supply standard out-of-warranty service rates and service contact information.
4. Bill of Materials: List of products supplied, and serial numbers of each product.
5. Product Datasheets and Shop Drawings: Manufacturer datasheets and shop drawings for each product and system supplied.
6. Manufacturer Owner / User Manuals: Manufacturer's Owner's or User's manual for each product, and Manufacturer's Installation instructions and other documentation supplied with the product.
7. Extra Material Schedule:

    a. Complete spare parts schedule for components of equipment furnished, which are not factory generic information, but accurate for the equipment provided.
    b. Itemized list of each piece of electrical, architectural and Owner equipment having electrical connections with circuit and panelboard locations; also, list related expendable equipment required for each item, such as fuse size and type, pilot lights, catalog numbers of fuses, overloads, etc. as applicable.
    c. Itemized list of each luminaire type with catalog number of replacement lamps, ballasts, boards, drivers, trims, lenses, accessories, etc.

8. Maintenance Procedures: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; testing, aligning and adjusting instructions.
9. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
10. Function and Operating Descriptions: Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
11. Operating Procedures: Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.
12. Include Product Certificates, Source quality-control test reports and Field Quality-Control Reports
13. Test Reports and Checklists: Test reports, checklists, and other forms generated and completed for the Project.
14. Training Information: Copy of training outlines/agendas, training session handouts, training sign-in sheets, and signed delivery receipt for each training session recording; Separate USB drive, labeled, for audio/video-recorded instructions to Owner, for operations and maintenance for each system.
15. As-Built Drawings.

1.3 AS-BUILT DRAWINGS

A. Obtain two complete sets of electrical prints and use them to provide progress record drawings which are separate, clean, prints reserved for the purpose of showing a complete picture of the work as actually installed (including routing of conduit and cables). These drawings also serve as work progress report sheets. Make notations, neat and legible thereon daily as work proceeds. Make these drawings available for inspection at all times and keep them at the job at a location designated by the Owner's Representative.

B. Maintain the clean, undamaged set of prints of drawings as well as a set of submittal drawings and coordination drawings. Mark the sets to show the actual installation where the installation varies from the Documents as originally shown. Include locations of underground and concealed items if placed other than shown on the Documents. Where shop drawings are used, record a cross-reference at the corresponding location on the Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

C. Show changes in: size, type, capacity, etc., of material, device or piece of equipment, location of device or piece of equipment; location of outlet or source of building service systems; routing of piping, conduit, or other building services. Record location of concealed equipment, electrical service work, conduits and other piping/work by indication of measured dimensions to each line from readily identifiable and accessible walls, column lines or corners of building. Indicate approved substitutions, modifications, and actual equipment and materials installed.

D. Affix near the titleblock on each drawing the Contractor’s Company Name(s), signature of Contractor’s Representative(s) and current date.

E. For electrical work installed below slabs, pavements, grade, etc., record location of nearby concealed water piping, sewers, wastes, vents, ducts, conduit and other piping, etc. by indication of measured dimensions to each line from readily identifiable and accessible walls or

corners of building and from adjacent electrical work. Show invert elevation of underground electrical work relative to work installed by other trades.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTRUCTION OF THE OWNER'S PERSONNEL

A. Provide instruction in the proper operation and maintenance of equipment that requires routine servicing. Include the following:

1. Review of operation and maintenance manuals.
2. Required tools.
3. Lubricants.
4. Extra Materials.
5. Cleaning.
6. Hazards.
7. Warranties and maintenance agreements.

B. Demonstrate equipment and systems operation including the following:

1. Start-up.
2. Shut-down.
3. Emergency conditions.
4. Safety procedures.
5. Setpoint and schedule adjustments.
6. Economy and efficiency adjustments.

END OF SECTION 260100

SECTION 260501 - COMMON WORK RESULTS FOR ELECTRIC

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 all sections.

1.2 GENERAL DIRECTION

A. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and had an opportunity to visit the site to be able to provide a comprehensive complete bid.

B. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes. Interpret these specifications in conjunction with the drawings and provide all work described. If work is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both. Should there be a conflict between the specifications and drawings, provide the greater quantity or better quality. Immediately notify owner's representative and design professional of such conflicts.

C. The drawings that accompany these specifications are diagrammatic and although size and location of equipment is drawn to scale wherever possible make use of submittal data and verify all dimensions on site. They do not show every conduit, offset or pull / junction box which may be required to install work in the space provided and avoid conflicts. The drawings are an outline to indicate the approximate location and arrangement of work. Follow the drawings as closely as is practical and install additional pull / junction boxes and offsets where required by site conditions and codes at no additional cost. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, all measurements should be taken in the field.

D. Coordinate all new work with all other contractors and installers in addition to existing building obstructions and install accordingly. Refer to coordination drawings of other trades. Comply with requirements of architectural drawings including but not limited to mounting height and locations.

E. Provide all labor and material, tools and equipment necessary to render all systems complete and operational, and ready for turnover to Owner. Work defined within this section applies for all Division 26 work, including work of Division 26 that is provided in support of work of other divisions. Unless specifically indicated otherwise in documents of other construction divisions, products to be installed shall also be furnished under Division 26.

F. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

G. Branch circuiting shown on drawings is also diagrammatic not intended to be the installation location. For instance, circuiting shown on the exterior of the building connecting building

mounted items shall be installed indoors concealed wherever possible. For circuits remote from the building, provide the work below grade unless otherwise indicated.

H. Complete work, or part(s) thereof, at times as may be designated by the Owner's Representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of it by Owner.

I. During mobilization or construction, if an abnormal condition is uncovered either with existing conditions, equipment loads, submittal data, etc. bring these to the attention of the Design Professional for review.

J. Owner's Representative or Design Professional may relocate fixtures, devices, equipment, etc. prior to installation within a 20-foot limit at no additional charge.

1.3 GENERAL STANDARDS

A. Provide work in compliance with applicable provisions of the following standards. Provide listing and labeling for all electrical materials, marked for respective intended uses, from UL or other Nationally Recognized Testing Laboratory (NRTL) that is acceptable to applicable Authorities Having Jurisdiction (AHJs).

B. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest adopted edition of applicable standards and adopted codes, including (but not limited to) the following.

1. International Building Code
2. State Building Code and applicable amendments
3. State Energy Code
4. Utility company requirements and standards as applicable
5. All provisions and requirements of NFPA (National Fire Protection Association)
6. National Electrical Code (NEC), NFPA 70
7. Life Safety Code, NFPA 101
8. Local governmental and other prevailing codes and ordinances
9. ADA/ADAAG requirements (American with Disabilities Act) including all applicable Standards for Accessible Design.
10. UL (Underwriters Laboratories Inc.)
11. ETL (Intertek Testing Services NA, Inc.)
12. CSA (CSA Group Testing and Certification Inc.)
13. FM (Factory Mutual Insurance Company)
14. ASME (American Society of Mechanical Engineers)
15. NEMA (National Electrical Manufacturers Association.
16. NECA (National Electrical Contractors Association)
17. IP (International Protection Rating / Ingress Protection Rating)

1.4 PERMITS AND REGULATIONS

A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this branch of the work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.

B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor and are hereby made a part of this contract.

1.5 DEFINITIONS

A. Furnish - Procure, supply and deliver to project site, ready for installation, install and warrant (unless indicated otherwise on documents). Include warranty expenses.

B. Install - Assemble, wire and connect loose-shipped components on site. Place in position for service or use, including material, labor, accessories, services, and testing. Wire, connect, and render fully operational for intended use.

C. Provide - Furnish and Install. Similar Terms: "include", “shall“, “equip with”, “consisting of”

D. Equal or Equivalent - Determination of equivalency to be made by design professional for all products not listed as basis-of-design.

E. Substantial Completion - Where frontend documentation does not define, products and systems must be fully installed as designed, tested, adjusted, labeled, and functionally demonstrated to owner.

F. NRTL: Nationally Recognized Testing Laboratory

G. OCPD: Overcurrent protective device.

H. SCCR: Short-circuit current rating.

1.6 REQUESTS FOR INFORMATION

A. Submit all questions, requests for information (RFIs) and similar queries through the formally-established RFI process for the project that has been accepted by the Owner’s Representative, Design Professionals, Prime Contractor and subcontractors. Submit as a PDF file. Do not submit as text in an email.

1.7 AVAILABILITY OF ELECTRONIC DRAWINGS

A. If expressly permitted by the Owner and the terms of the Contract, editable electronic drawings may be made available for the creation of shop and as-built drawings upon request. Drawings will be made available at the discretion of the Engineer.

B. “Request Drawings” form can be accessed, filled out and submitted at http://www.klhengrs.com (right hand side of page - Contractor Resources). Direct access to this form can be found here: http://files.klhengrs.com/requestdrawings.html

1.8 QUALITY ASSURANCE

A. Contractor shall have a minimum five (5) years experience in the installation of systems similar to the systems specified. Contractor if requested shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor's inability to perform.

B. Contactor and all workers trained in electrical safety as required by NFPA 70E.

1.9 WARRANTY / GUARANTEE

A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner's option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Provide materials that are new, full weight, of the best quality. Provide similar materials that are of the same type and manufacturer. Provide materials, apparatus and equipment with NRTL listing and label where regularly supplied. Provide only products that are intended for, rated for and suitable for the installed condition.

B. Provide basis of design products or listed products equivalent in quality, performance, aesthetics, and product support (factory and local) to that specified as basis of design. Products not basis of design are subject to review by the Design Professional and possible rejection. Listing of a product manufacturer by name alone as an equivalent manufacturer shall not equate all products offered by that manufacturer to the basis of design.

C. Bear all costs incurred from deviation from basis-of-design materials, methods, labor, services, etc. Use of materials, methods, labor, services, etc. that deviate from the basis-of-design will be considered a statement that capacities, requirements, clearances, arrangements, performance, etc. have been checked, verified, found satisfactory, and align with intent of specified work and applicable codes and regulations.

D. Should deviation from basis of design equipment impact other contractors scope of work it shall be the responsibility of this contractor to coordinate with and cover these costs in addition to their own.

PART 3 - EXECUTION

3.1 GENERAL DIRECTION

A. Unless specifically indicated, provide all specified and drawn work as required to render all equipment and systems fully operational, including all ancillary, accessory, and support work.

B. Install equipment and materials in strict accordance with manufacturer's written instructions. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque values.

C. In cases where products / materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.

D. Wire and connect electrical equipment furnished under this branch of work, other branches of work and by the Owner. Review documents of other trades to identify electrically operated/controlled equipment that is furnished or installed by the Owner, or by other trades. Provide power connections and local disconnects for same. Provide control wiring (including relays, starters, programming, etc.), as required to render equipment fully operable.

E. Except where otherwise indicated, provide fully-rated or series-rated overcurrent protection (OCP). Provide equipment and OCP rated to meet or exceed the calculated available series-rated fault current at the respective node in the power distribution system. Series-rated breakers/systems are not permitted where prohibited by prevailing codes and standards, including applications involving motor contribution as addressed in Article 240.86(C) of NFPA 70.

F. Remove and replace items that may impede new work installation including but not limited to fencing, doors, gypsum, lift-out panels, and structures to provide pathway for moving equipment into place.

G. Examine surfaces to receive products for suitable mounting conditions and verify compliance with installation tolerances and other conditions affecting performance of the work. Proceed with installation only after unsatisfactory conditions have been corrected.

H. Drawings indicate dimensions for typical equipment configurations including clearances between equipment and adjacent surfaces and other items. Ensure selected products and equals comply with layout provided and required clearances.

3.2 SUPERVISION AND WORKMANSHIP

A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.

B. Furnish the services of an experienced superintendent to be in constant charge of the work at all times.

C. Provisions shall be made for owner's representative or design professional to make rough-in and open ceiling inspections prior to covering up work.

3.3 CHANGE OF WORK

A. In the event of revised scope or work formally issued through Change of Work order, contractor shall provide an itemized breakdown of pricing and receive approval prior to commencing with work.

3.4 COORDINATION

A. Commence with coordination in a timely manner. Subsequent additional compensation, special allowances, additional construction time, etc. will not result from failure to coordinate (including providing related information to other trades for review) in a timely manner. Do not plan, fabricate or install work before consulting with and properly coordinating with other trades so that work will not interfere with that of other trades.

B. Coordinate layout and installation of equipment and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

C. Participate in multi-trade coordination efforts prior to commencing with material procurement or installations. Participate in preparation of coordination drawings by other trades, prior to fabrication or installation of equipment, materials, etc. Coordinate actual clearances of installed equipment. Coordinate exact location of electrical outlets, lighting fixtures, conduits, raceways, equipment, cable assemblies, applicable devices, etc. well in advance of installation so there will be no interferences at installation between the various trades.

D. Ensure that required workspace clearances, required clearances for access and maintenance and electrical working clearances of all devices and equipment complies with NEC (NFPA 70) Article 110. This also applies to finalizing locations of disconnects, starters, contactors and other electrically operated equipment that may require testing or maintenance while energized. Layout all affected equipment on paper, and meet with electrical inspector on-site as needed, prior to ordering related materials or commencing with installations, to ensure compliance with NEC Article 110.

E. Coordinate and correct conflicts in equipment and materials prior to installation. If a conflict cannot be resolved, refer the matter to the Owner's Representative for a final decision as to method and material.

3.5 ARCHITECTURAL COORDINATION ITEMS

A. Cutting and Patching:

1. Hold cutting and patching to a minimum by arranging with other trades for sleeves and openings before construction is started.

2. Cut and drill all openings in roofs, walls, and floors required to perform the work. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started. When drilling / cutting concrete slabs, utilize ground penetrating radar (GPR) and/or X-ray scanning equipment to verify the location is free from obstruction, including but not limited to: structural rebar / strands / tendons and electrical conduit / wiring. Repair all damage to structural elements that may occur. Provide temporary partitions, dust barriers, vacuums to keep all dust to a minimum. Allow inspection by owner's rep and inspection by authority having jurisdiction prior to concealing any work or uncover and restore work to allow for observation.

B. Fire Caulking:

1. Fire stopping requirements/locations are not indicated on electrical drawings. Review architectural and other drawings to determine where there will be fire/smoke rated walls, floors, membranes, etc. and rating requirements of same. Provide required fire stopping work associated with electrically related penetrations. Patching through fire rated walls and enclosures shall not diminish the rating of wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch / sealant / pillow / grommet / compound / etc. Clean affected surfaces, joints, etc. immediately before applying fire stopping and only apply under recommended temperature and humidity. Apply primer as required by manufacturer. Properly tool sealants for clean look. Subject to compliance with requirements, provide products by one of the following:

   a. Fire Stop Pillows: Nelson PLW, STI, Hilti, 3M
   b. Fire Stop Putty: Nelson FSP, STI, Hilti, 3M
   c. Latex Intumescent Sealant: Nelson LBS3, STI, Hilti, 3M
   d. Outlet boxes: Nelson FSP, STI, Hilti, 3M

C. Access Panels:

1. Provide all access panels required for proper servicing of equipment or access to junction boxes as a last resort after first searching out locations for equipment and junction boxes in accessible areas. All access panel locations and sizes must be coordinated with and approved by design team and owner's representative. Provide fire rated and smoke rated access panels where required. Provide frame as required for finish. Coordinate installation with General Contractor as they may elect to install access panel. Exact location(s) must be approved by the Architect. Minimum size to be 12" x 12" for junction boxes and 22" x 22" for equipment, units to be 16-gauge steel, primed for paint, door opens beyond 90 degrees and locking device shall be screwdriver cam locks.
2. For equipment or junction boxes above gypsum board or "hard ceilings", provide equipment access panels sized to permit complete holistic removal of the unit in its entirety. Access panel shall also be sized to accommodate removal of the largest piece of equipment in the case where such access panel is used as a removal pathway for multiple pieces of equipment. Subject to compliance with requirements, provide products by one of the following:

   a. Bar-Co., Inc.
   b. J.L. Industries.
   c. Karp Associates, Inc.
   d. Milcor Div. Inryco, Inc.
   e. Nystrom, Inc.

D. Conduit Sleeves:

1. Aboveground, exterior wall penetrations: rigid steel pipe sleeve.
2. Below grade, exterior wall and floor penetrations: schedule 40 cast iron pipe sleeve
3. PVC Pipe Sleeves where allowed: ASTM D 1785, Gray, Schedule 40.
4. Rectangular opening sleeves: Galvanized Sheet Steel, thickness min 0.1 inches.
5. Sleeve Seal Systems: Provide modular sealing device designed for field assembly, EPDM, Nitrile or Silicone based on installation environment with stainless steel bolts and polymer pressure plates. Install type and number recommended by manufacturer for a water tight seal. Provide by one of the following:

    a. Advance Products & Systems, Inc.
    b. CALPICO, Inc.
    c. Metraflex Company (The).
    d. Pipeline Seal and Insulator, Inc.
    e. Proco Products, Inc.
    f. OZ/Gedney
    g. Link-Seal

6. Sleeve Seal Fittings: Provide manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Install in wall or slab as constructed and grout area around fitting. Provide by one of the following:

    a. Presealed Systems
    b. Bio FireShied
    c. MetaCaulk

7. Sleeves shall be cut flush with both faces of wall. Deburr all sleeves. Floor sleeves shall extend one inch above floor top elevation. Maintain all fire ratings. Use joint compound for around gypsum sleeves. Roof penetrations shall be with flexible boot-type flashing unit or within a pipe curb assembly equal to Pate Co. Curb and flashing per roofing manufacturer’s requirements to maintain warranty.

E. Grout:

1. Provide non-shrink grout, recommended for sealing openings in non-fire-rated walls or floors, ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout. Provide 5000-psi strength design mix, premixed and factory packaged.

F. Silicone Sealants:

1. Provide single-component, silicone-based, neutral-curing elastomeric sealant for exterior work. Provide pourable (self-leveling) grade formulation for openings in non-fire rated floors and other horizontal surfaces. Install only in temperature and humidity as recommended by manufacturer. Colors of all visible sealants to be clear or color approved by owner’s rep or design team.

G. Acrylic Sealants:

1. Provide one-part, non-sag, mildew-resistant, paintable recommended for exposed applications of interior and protected exterior locations

3.6 PROTECTION OF SURFACES

A. Make every effort to protect roofs, walls and floors from foot traffic, equipment, carts, lifts, etc. Make roof penetrations and install insulated roof curbs and flashing in accordance with roofing manufacturer's recommendations. Obtain written certification from roofing manufacturer that work has been performed properly and that roof warranty is intact.

3.7 UTILITY VERIFICATION REQUIREMENTS

A. Field verify locations of underground and aboveground utilities, or those otherwise obscured from view, in the vicinity of work prior to commencing work. Utilize "811" call before you dig and hire locating service to identify, locate and mark remaining utilities and private lines. Obtain on-site approval from local utility prior to connecting services. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

3.8 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Receive, inspect, store and protect all materials required for new work. Do not accept or install any product damaged in any way.

B. Comply with all manufacturer guidelines and requirements for movement, storage, and protection of new work. All new work must be stored in a clean, dry place protected from weather and construction traffic. Maintain acceptable temperature and humidity per manufacturer recommendations. When stored inside or during transport through building, do not exceed structural capacity of the floor.

C. Coordinate and account for sizes of all new work included shipping materials with available openings. Account for rigging of all new work as required and as intended by manufacturer.

D. Do not install work until work area is sufficiently weathertight, all wet work in area is complete and all work above is complete. Provide temporary heating, cooling or humidity control to maintain acceptable conditions for install per manufacturer recommendations until permanent equipment operational.

E. Prior to installation, all products shall have the ability to be returned to the supplier or manufacturer after purchase and charged a reasonable restocking fee equal to a small portion of the cost.

F. Protect all new work through construction from damage. Take safeguards necessary to protect from damage. Items damaged during construction will not be accepted and shall be replaced with new.

G. Remove and replace all materials that have been installed improperly, physically damaged, moisture or water damaged, or mold damaged.

H. Fully remove all packaging materials inside and out prior to startup.

3.9 INTERRUPTION OF SERVICES

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others without notification to Owner's Representative and written permission. Arrange for and provide temporary electric service meeting requirements of owner. Notify Owner's Representative no fewer than fourteen days in advance of proposed interruption of electric service.

3.10 STARTUP, TESTING AND ADJUSTMENTS

A. Engage a factory-authorized service representative to perform startup service. Perform tests and inspections and prepare reports for submission. Take corrective action for all non-conforming tests.

B. Prior to energizing, test wires and cables for proper phase to phase connections, electrical continuity and short-circuits. Properly reference and resistance test grounding electrode and equipment grounding conductors. Test service voltage and configuration and take corrective action if necessary. Verify circuit voltage at source prior to energizing any feeder or branch circuit. Energize circuitry and demonstrate capability and compliance with requirements. Ensure the direction of rotation of each motor. Adjust controls, remote monitoring, safeties, operations, moving parts, etc. as applicable. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Complete installation and startup checks according to manufacturer's written instructions.

C. Set and document final settings of field-adjustable circuit-breaker overcurrent trip values.

3.11 CLEANING EQUIPMENT AND PREMISES

A. Vacuum, clean and wipe down all new work and equipment inside and out. Exposed parts which are to be painted shall be cleaned of all foreign objects and prepped for paint.

B. During the progress of work, clean up and leave the premises and portions of the building in which work has occurred in a clean and safe condition. Provide this cleaning on a per-shift basis.

3.12 DEMONSTRATION / TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to product specific specification for training types and duration.

3.13 PROGRAMMABLE AND SOFTWARE OPERATED EQUIPMENT

A. This subsection applies for systems that incorporate microprocessor based equipment and components. The systems themselves are specified elsewhere within Project Manual.

1. Program software and equipment specifically for phased turnover of spaces based on construction phases. Program, check, and test each system using respective certified factory technician.
2. Room names and numbers may change from architectural drawing names and numbers to actual operational room names and numbers. Contact Design Professionals and Owner to determine actual operating room names, room numbers, etc. and program using actual operational information. Provide interim and permanent programming and configuration work as required to render and maintain systems in full operation.
3. Provide and adapt as necessary the latest release of system software and provide upgrade(s) at final close-out of project.
4. All programming shall be commented in detail and turned over to owner in hard copy printed form and in electronic form on USB drive. This information shall be provided with Operations & Maintenance Manual submission.
5. Existing Systems: Become familiar with existing characteristics, devices, equipment, cabling, configuration, components and programming of affected systems so that expansions, extensions, and retrofits are fully compatible with the existing conditions. Verify that systems are in proper working order prior to beginning work on an existing system. If not, bring defects to the attention of the Owner's Representative. If no notification occurs, it is assumed that the system was in working order. Provide remedial work for subsequent system problems that occur, if any.

END OF SECTION 260501

SECTION 260502 - COMMON ELECTRIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 GENERAL

A. Mounting Heights: Outlet mounting heights as indicated on the plans are approximate. Determine the exact mounting heights (and locations) of outlets in the field with relation to architectural detail and equipment being served. Coordinate outlet location with equipment, with furniture plans and with architectural elevation plans. Where mounting heights are not detailed or dimensioned, contact the Owner's Representative for direction. Prior to rough-in, coordinate final mounting heights of system outlet boxes in field with Owner's Representative. Install boxes at heights as follows, to center of box, unless directed otherwise in field or otherwise noted on E-series drawings or architectural plans. In cases where using center of box for measurement would result in a switch-height device having an operable component higher than 48 inches above finished floor, install boxes lower as needed so that uppermost part of operable component is no higher than 48 inches. Height of boxes dimensioned from ceiling apply to rooms having ceilings 9' or less; in rooms having higher ceilings, locate these as directed in the field.

Switches – Elsewhere:	46”
Occupancy Sensors, Elsewhere:	As recommended by manufacturer
Receptacles:	18”
Starters:	46”
Disconnects:	46”
Circuit Breaker Panelboards:	72” to top unless code dictates otherwise
Wall Mounted Luminaires:	As noted on plans or directed by Design Prof.

B. Lock-Out Tag-Out Devices: Provide permanently installed lock-out tag-out devices compliant with NFPA 70 and OSHA, with padlocking provisions, at source overcurrent devices for the following applications.

1. Where the normal NFPA 70-compliant location of the disconnecting means is impracticable or introduces additional or increased hazards to persons or property.
2. Where required by NFPA 70.
3. Where required by OSHA.
4. Where required by any other authority having jurisdiction.

C. Electrical Installations:

1. Install conduit, wiring, outlet box and junction box type work in finished areas concealed. Such work installed in unfinished areas may be exposed only at the discretion of the Owner's Representative.
2. All new electrically related work shall be supported directly from building structural members. New electrically related work shall not be supported from ductwork, ductwork hangers, ceiling supports, existing conduit supports, etc. All conduits (and cable assemblies, where applicable) shall be routed parallel to building structural members. Noncompliant work installed by the electrical contractor shall be removed and reinstalled to the satisfaction of the Owner’s Representative and the Design Professionals, at the expense of the electrical contractor.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
4. Provide systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components. Provide factory-furnished filler plates in unused spaces of manufactured equipment.
5. Install electrical equipment to facilitate servicing, maintenance, and repair and replacement of equipment components. Install equipment for ease of disconnecting, with minimum of interference with other installations. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope. Protect the structure, furnishings, finishes, and adjacent materials.
6. Verify dimensions by field measurements. Take measurements and be responsible for exact size and locations of openings required for the installation of work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, follow direction of the Owner's Representative.
7. Provide no wire size smaller than No. 12 for branch circuits unless otherwise noted on plans for control circuits, or otherwise indicated in a Division 26 specification section. Provide larger sizes where required by prevailing codes or indicated on contract documents. Provide neutral conductor for all multi-pole feeders. Provide grounded (“neutral”) conductor(s) for all multi-pole feeders and branch circuits unless this contractor determines in field that the affected load(s) will never have need for a neutral conductor and NEC does not mandate otherwise. Provide minimum 3/4” conduit size.
8. Do not install device wall outlets directly back to back, where located on opposite sides of common walls. Offset outlets by at least two feet for applications in fire rated walls and smoke rated walls and applications in acoustically treated walls. Offset outlets by at least one foot for other applications.
9. Provide wires continuous from outlet to outlet and properly splice joints. Provide insulation value for joints 100% greater than that of the wire. Mechanical wire splicers may be used. Where friction and rubber tape is used, provide tape conforming to Federal Specifications HH-T-11 and HH-T-111. Where plastic electrical tape is used, provide Scotch #33, or approved equal. Provide minimum 8” tail for conductors terminating at each wired outlet at their outlet fittings to facilitate installment of devices, luminaires, etc.
10. Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are <u>not</u> permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices, equipment or other electrical work.
11. If during construction it becomes apparent that some specific minor changes in layout will result in a neater job or better arrangement, make such alterations without additional compensation and without having to offer credit. Obtain Design Professional’s review before making such changes. Provide workmanship throughout that conforms to the standards of best practice. Marks, dents and finish scratches are prohibited on exposed materials, luminaires, fittings, etc. Clean inside of panels and equipment boxes.
12. Special Occupancies: Provide all electrical work in Special Occupancies as defined and described in Chapter 5 of NFPA 70 in strict compliance with Chapter 5 of NFPA 70, in addition to compliance with specified and drawn requirements of Division 26.

D. Connectors and Connections:

1. Provide complete assembly of materials for each type of required electrical connection, including but not limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

2. Unless otherwise indicated, provide wires/cables (conductors) for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals, and that are recommended by equipment manufacturer for intended applications. Provide connectors that are specifically UL listed and labeled for the exact splicing/termination application, including for instances where solid conductors are spliced/connected to stranded conductors. Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts, cable ties, etc. as recommended for use by accessories manufacturers for intended applications.
3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment. Cover splices with electrical insulating material to achieve insulation at least 100 percent in excess of electrical insulation rating of those conductors being spliced. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Do not "ring" copper conductors while skinning wire.
4. Ground metal frames of portable and stationary direct-wired electrically operated equipment by connecting frames to the circuit equipment grounding conductor and to grounded metal raceway. Provide necessary electrical connections between the specified equipment and junction boxes, disconnect switches, and starters near equipment with flexible metallic conduit and matched connectors. Do not expose flexible conduit in finished areas.
5. Wire and connect electrical equipment furnished under this branch of work, other branches of work and by the Owner. Review documents of other trades to identify electrically operated/controlled equipment that is furnished or installed by the Owner, or by other trades. Provide power connections and local disconnects for same. Provide control wiring (including relays, starters, etc.), as required to render equipment fully operable unless indicated otherwise on drawings or in project manual. Determine exact requirements in field from respective equipment installer.

PART 2 - PRODUCTS (INCLUDED IN PART 1 ABOVE AS APPLICABLE)

PART 3 - EXECUTION (INCLUDED IN PART 1 ABOVE AS APPLICABLE)

END OF SECTION 260502

SECTION 260503 - SUBMITTALS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. The contractor is not relieved of responsibility for providing specified or drawn scope of work should any errors or omissions in submittal information not be noted by the Design Professional during submittal reviews or site observations.

B. Submittal requirements of this section apply to all Division 26 sections. Note that some Division 26 sections may also have additional requirements that are unique to the specific section, which would be requirements in addition to those stated in this section. Furnish submittals for each Section that includes one or more of the following elements of work: supply, installation, integration, programming, creation, labeling, and/or contractor-based design or engineering, of one or more products or systems. If a manufacturer is proposed but not listed in a particular specification section, submit as a substitute.

C. Furnish submittals in electronic (PDF) format. Provide electronic submittal files that are compatible for opening and viewing with electronic PDF file readers that fully support and recognize the Adobe PDF Portable Document Format Standard. Assemble single PDF file submittals from a series of individual files that are organized, indexed, bound together as one composite file that is bookmarked if needed to aid the reviewer in navigating the content. The file name used to label the submittal shall be the section number followed by the submittal instance number for that Section (e.g., 260519-PD-01.pdf).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Route submittals through established Project channels as identified by the Owner's Representative. Coordinate, assemble, title, transmit and track Project submittals. Label each submittal of each type similarly for consistency and so they appear as if prepared by the same entity. Like-type submittals (e.g., Product Data) from different Sections shall have the same appearance and organization as those of other Sections. Submittal items listed in this Section represent the common items required to be supplied for the various specification Sections throughout the duration of the Project. Individual Sections may include additional requirements. Design Professional reserves the right to require additional submittals or to waive select submittal requirements on a Section-by-Section basis.

B. Furnish submittals for all materials proposed for use for the project, using products compliant with all respective specifications and with information shown on drawings. Furnish submittals for different Sections each with its own transmittal form. A single transmittal shall not be used to identify submittals for more than one (1) Section at a time. Organize submittals as identified in the Contract Documents. Supply separate submittals for each Section. Do not combine multiple Sections together into a single submittal, except where expressly directed within the Contract Documents. The format for labeling the submittals shall be as follows: Section Number–

Submittal Type Abbreviation–Submittal Iteration (examples: First Product Data Submittal for Section 260519: “260519-PD-00”; revised Product Data Submittal for Section 260519: “260519-PD-01.”).

3.2 SUBMITTAL REQUIREMENTS

A. General:

1. Transmittal: Supply a dedicated transmittal for submittals for each individual Section. Itemize the specific submittals included by Section, submittal type, and iteration.
2. Title Sheet: Include a separate title sheet (including index) with each submittal, of each type. Title sheets for each Section, for each submittal type, shall have the same appearance, 8-1/2 inches x 11 inches for product data submittals. Title sheets for drawings shall be the same size as the associated drawings. Create title sheets with appearance and information identified on the sample title sheet at the end of this Section.
3. Title Blocks: Create drawing submittals on the Contractor’s, manufacturers, or vendor’s own title block, not using those of the Owner, Design Professionals or their Consultants.
4. Legend: Drawing submittals shall include a legend of symbology.
5. Resubmittals: Resubmittals shall include a replica of the reviewer’s comments that necessitated the resubmittal, along with an accompanying item-by-item explanation of the actions taken and changes that will be found within the resubmittal.
6. Submittal requirements indicated in this section apply for all specification sections with products and materials, and are supplemental to and in addition to submittal requirements that may be included in product and material specification sections.

B. Informational Submittals – Submit this information as part of the Operations and Maintenance Manual.

1. Product Certificates: For each applicable product or system, from manufacturer.
2. Source quality-control test reports.
3. Field Quality-Control Reports:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Quality Assurance Submittals (QA):

1. Furnish upon request when not expressly requested to be supplied with bid. When requested, furnish to the Design Professional within 2 business days.

    a. Qualification Data for testing agencies, including detailing of scope of services for the project.
    b. Furnish list of Subcontractors to be used on the Project along with a description of the role each shall play on the Project, and the last six (6) projects that the Contractor (and each proposed Subcontractor) has completed that are of similar scope, size and contract value.

D. Product Data Submittals (PD): Submit following contract award or notice of intent to award a contract. Submit and obtain review(s) prior to procurement or fabrication of materials. Provide separate manufacturer datasheets for each product, which shall be manufacturer originals of

the manufacturer's official electronic datasheet. Distributor modified, distributor branded, and/or html based "web" datasheets are not acceptable. For all materials, equipment, components and ancillary materials, include the following as applicable: voltage; phase; frequency; short circuit ratings; load; dimensions; technical data; enclosure types; required clearances; weights; methods of field assembly and installations; diagrams; configurations; capacities; finishes; construction; overcurrent protection; features; performance; electrical characteristics ratings; finishes; accessories; NRTL listing for series rated devices; time-current coordination curves for each type and rating of overcurrent protective device, including selectable ranges for each; all pertinent technical support data; factory settings; etc. Where manufacturer's datasheets depict multiple products, versions and options, indicate via highlighting, underlining, or bold visible arrows the models, versions, colors, options, etc. being supplied. Indicate and identify exact catalog numbers. Comply with applicable standards of UL or NRTL.

E. Shop Drawing Submittals (SD): Submit following contract award or notice of intent to award a contract. Submit and obtain review(s) prior to procurement or fabrication of materials. Submit concurrently with section-specific product data submittals where both apply. Draw plans, elevations, sections, elevations and sizes to scale. Show and details, features, characteristics, ratings, factory settings, nameplates, legends, bus structure, capacities, features, accessories, locations of pertinent items, schematics, wiring diagrams, production drawings, etc. Furnish schematic drawings with all information required to install, identify, connect, wire, program, maintain, etc. the system(s). Comply with applicable standards of NRTL.

F. Sample Submittals (SS): Submit concurrent with, or soon after, product data and shop drawings and prior to installation of Work. Furnish physical samples where applicable, in quantities as directed by Owner's Representative.

G. Training Submittals (TG): Submit thirty (30) days prior to the first training session. Furnish proposed schedule, training agendas for each session, identification of personnel that will conduct training, and handouts proposed for distribution during training. Record all training sessions and include within O&M Manual.

H. Closeout Submittals (CO):

1. Submit following completion of onsite work.
2. Operation and Maintenance Manuals:

    a. Provide on USB drive(s). Provide sub-directories on the drive(s) to label and separate contents for the manual.

3. As-Built Drawings

    a. Provide on USB drive(s).

I. Extra Materials: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Generate report indicating all maintenance materials turned over to owner and obtain signature from owner acknowledging receipt.

3.3 SUBMITTAL RESPONSES

A. Revise and Resubmit: When a submittal is marked “Revise and Resubmit,” the entire submittal shall be reviewed, revised and resubmitted in totality unless specifically indicated otherwise. Resubmittals shall be checked for compliance with the Contract Documents, inclusive of requirements for submittals. In addition, any comments and deficiencies identified by the reviewer shall be appropriately acted upon. Uniquely identify specific portions of each resubmittal that have been modified since the previous version was reviewed. Resubmittals shall include a copy of the reviewer’s previous comments, include a written description of the action(s) taken, be labeled chronologically, and be inclusive of all corrective action identified by the previous reviewer.

B. Exceptions Noted: When a submittal is marked “Exceptions Noted,” the specific actions identified shall be taken. No further submittal actions required

C. No Exceptions: When a submittal is marked “No Exceptions”, no further actions are required.

END OF SECTION 260503

SUBMITTAL TITLE SHEET
EXAMPLE
(Form: Sub-1)

PROJECT TITLE:

Project Name Line 1
Project Name Line 2
Project Name Line 2

SUBMITTAL TYPE:

Product Data

SECTION SUBMITTAL NUMBER

260519-PD-00

SECTION TITLE:

Section Name

Date Prepared:

yyyy-mm-dd

CONTRACTOR OF RECORD:

Firm Name
Address1
Address 2
City, State, Zip
Phone (000) 000-0000, Fax (000) 000-0000
Project Manager: Full Name
PM E-Mail: xxxxxxxx@xxxx.xxx

SECTION SUBCONTRACTOR(S):

Firm Name
Address 1
Address 2
City, State Zip
Phone (000) 000-0000
Fax (000) 000-0000
PM Name: Full Name
PM E-Mail: xxxxxxxxx@xxxx.xx

Firm Name
Address 1
Address 2
City, State Zip
Phone (000) 000-0000
Fax (000) 000-0000
PM Name: Full Name
PM E-Mail: xxxxxxxxx@xxxx.xx

SECTION 260505 - EXISTING CONDITIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Perform a detailed pre-bid walk-through field inspection to review the existing structures and premises, to determine existing conditions, and to determine scope of required electrically related work. Include applicable accessible ceiling cavity areas in this inspection.

B. It is not the intent of this section, or of drawings, that existing conditions be accurately shown. Existing electrical work is shown to a very limited extent on drawings and is shown for general planning reference only. Locations and information were derived from cursory visual observations or from portions of documents that were prepared for previously installed work (not from record drawings or "as-builts").

C. Do not reuse removed electrical materials unless specifically indicated in project manual or on drawings. Existing wiring systems may be utilized only to the extent indicated in project manual, or on drawings, or as directed by Owner's Representative in field.

D. Hold routing of new raceways in existing buildings as tightly as possible to the structure above. Obtain approval of Owner's Representative prior to installation.

E. If required to accommodate construction related activities temporarily remove, store in protected location on site, and reinstall conflicting electrical equipment, luminaires, or devices that are to remain or to be relocated. The following applies to electrical materials that will remain or be reused under this project.

1. Protect during construction activities.
2. Clean and re-lamp luminaires immediately prior to occupancy of the finished construction area.
3. Clean and service (if service is required) equipment in the construction area immediately prior to occupancy of the area.

F. Affect on Adjacent Occupied Areas:

1. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner’s Representative. Provide temporary service during interruptions to existing facilities. Schedule momentary outages when necessary for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove related wiring that has been abandoned.
2. Carefully coordinate work and system shutdowns in advance with Owner's Representative, and with affected trades so that normal building activities and other construction trades are minimally affected. Perform electrically related construction work, which will affect an occupied area (including those which are located outside the immediate area of project work) at special times as directed by Owner's Representative in field.
3. Provide work in a manner that ensures existing systems and components remain fully operational in occupied spaces during occupied periods.

4. Provide and maintain temporary partitions and dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and other system components. Protect adjacent installations during cutting and patching operations. Remove protection and barriers after demolition operations are complete.
5. Interim Air Quality (IAQ) Work: Prevent airborne dust and particulate matter resulting from electrical work from entering occupied spaces, and from entering air intakes to operating HVAC systems. Make required electrical openings through walls and floors immediately prior to installation of work. Properly and permanently seal electrical openings immediately after installation of work. Provide temporary seals for applications where penetrations are made but cannot be permanently sealed within four hours.

1.2 EXISTING POWER DISTRIBUTION EQUIPMENT

A. This subsection applies for adding components to existing power distribution equipment. Unless specifically indicated otherwise on drawings or in specifications provide new breaker in instances where new circuits or feeders are shown connected to existing circuit breaker type power distribution equipment.

1. Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings required. Provide breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct breakers for mounting and operating in any physical position, and operating in a minimum ambient temperature of 40 deg C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated. All branch circuit breakers shall be full ambient compensated thermal magnetic molded case with quick-make and quick-break action and positive handle trip indication, both on manual and on automatic operation.
2. Breakers shall be of the over-the-center toggle operating type with the handle going to a position between "on" and "off" to indicate automatic tripping. All circuit breakers shall be full size. Do not use “tandem" or "split" breakers. All multi-pole breakers shall have internal common trip with all load side box lugs of one breaker in the same gutter. All circuit breakers shall have sealed cases to prevent tampering.
3. All 15 and 20 ampere branch circuit breakers shall be UL Listed as SWD (switching duty). All 15-70 ampere branch circuit breakers shall be HACR Type. All branch circuit breakers serving all ballasted (fluorescent/HID) lighting loads shall be HID rated. Provide handle lock-on devices of the non-padlocking type for life safety, special systems and other essential circuits.

B. Provide components that are manufactured by the same manufacturer as the existing equipment in which they will be installed, and that are intended by the manufacturer to be installed in said equipment. Provide components with fault current (A.I.C.) ratings that meet or exceed the ratings of the existing power distribution equipment. In existing buildings where fault current values are not indicated on drawings, coordinate with existing “upstream” distribution equipment, and provide equipment AIC ratings that meet or exceed same.

C. Determine which existing branch circuits must remain active. Reconnect (or maintain in operation as applicable) and schedule them. Completely re-type panelboard directories for panelboards affected by this project using accurate “as-built” information. Where applicable for multi-wire branch circuits that are reused to feed new or replacement equipment designated on drawings, replace existing single-pole breakers with multi-pole breakers compliant with NFPA 70. Where applicable ensure that reconnected shared neutrals are properly balanced with the correct phase conductors. Where applicable, provide correct color-coding for insulation of

reconnected conductors in a manner compliant with NEC. All specific scheduling shown on drawings is shown to indicate new branch circuiting requirements. Exact numbering sequence of circuits shall be determined by this contractor in field after this contractor has made adjustments as may be necessary for load balancing.

1.3 PRE-EXISTING CODE VIOLATIONS

A. Inspect existing electrical work in areas accessed under this project and bring into compliance with current NEC. This applies only to the extent that such work is uncovered in the immediate project areas affected by construction activities, and only to the limited extent that it applies to pre-existing general installation methods such as missing J.B. plate, open J.B. knockout, minor conduit re-anchoring and minor exposed wiring/connections. If more extensive code or safety violations are discovered, immediately bring them to the attention of the Owner's Representative (detailed in writing) along with proposed cost for corrections and impact (if any) on the construction schedule.

1.4 POWER CONTINUITY REQUIREMENTS

A. The following notes broadly define some of the specialty base bid scope of work required to provide special temporary power for existing facilities to accommodate utility power interruptions. Field-verify all specifics and provide materials, normal time labor, premium time labor, services, safety measures, etc. for all work under base bid, including but not limited to the following.

1. Minimize risks to individuals and property throughout the duration of the project. Keep full electrical services online during all periods of time that any affected facility is occupied. Coordinate with and obtain approval from the Owner and Design Professionals for all materials, methods, steps, locations, installations, etc. prior to commencement of work. Comply with NFPA 70E. Determine and employ means and methods as required to safely and securely implement all related work.
2. Do not interrupt electrical utility service(s) to the facility, or any part thereof, unless permitted under the following conditions, and then only after providing temporary electrical service(s)/feeds.

    a. Notify Owner and Design Professionals no fewer than fourteen days in advance of each proposed interruption of an electrical service.
    b. Do not proceed with interruption of an electrical service without Owner's written permission.
    c. Do not energize any new work without notification to, and subsequent permission from, the Owner.

3. During construction related electrical outages, switchovers, disconnections, reconnections, etc., provide all temporary insulated conductors, taps, jumpers, etc. to and from existing and new or temporary electrical equipment, including but not limited to, conductors, splices, lug fittings, rework, etc.
4. Schedule outages in advance with Owner, at days of week and times of day or night as directed by Owner, as necessary to accommodate all construction related electrical outages, switchovers and related connections and disconnections.

1.5 INTERIM LIFE SAFETY WORK

A. Provide interim electrical fire alarm and life safety protection in demolition and construction areas as indicated below. Contact Design Professionals if further definition is needed.

1. Provide temporary plastic covers for smoke detectors, obtained from smoke detector manufacturer or obtained from a third party and specifically approved for such use by smoke detector manufacturer, over existing smoke detectors within project area, and in adjacent areas that are exposed to construction-related dust or airborne particulates, during working periods. Remove covers after each shift.
2. Provide temporary emergency egress lighting along egress routes affected by this project. Remove this work when no longer needed.
3. Provide temporary emergency exit lighting along egress routes affected by this project. Remove this work when no longer needed.

1.6 DEMOLITION

A. Where the term “demolition” is used herein, interpret it to mean “demolition” or “selective demolition” as applicable.

1. Provide electrical demolition work as required to accommodate project demolition and as required to accommodate new construction.
2. Disconnect and remove work to be abandoned, and as required to accommodate work of other trades, in areas affected by this project unless specifically noted otherwise on plans or determined otherwise during pre-demolition survey.
3. Remove accessible abandoned, inactive and obsolete raceway systems. Remove abandoned, inactive and obsolete wiring and controls. Remove abandoned, inactive and obsolete equipment, luminaires and devices. Abandoned raceways embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove abandoned electrical materials above accessible ceilings.
4. Remove related abandoned unused raceway back to the nearest respective "upstream" junction box that remains active even if outside of the confines of the project area. Remove abandoned unused wiring back to its source even if sources are outside the confines of the project area.
5. Rework and extend raceway and wiring as required to accommodate new or relocated work.
6. Locate, identify, and protect electrical services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services.
7. It is recognized that there may be some conduit systems rendered inactive by demolition, causing disconnection of "downstream" outlets, etc. Investigate these types of conditions (for all systems) prior to demolition. Provide necessary corrective electrical work prior to demolition to ensure that such "downstream" devices remain permanently active throughout demolition, during new construction, and after project completion.
8. Perform cutting and patching required for demolition and admission of new work, and restore to neatly match surrounding surfaces, including fire/smoke ratings.
9. Coordinate work carefully with Owner’s Representative prior to beginning electrical demolition work.
10. Maintain (or reconnect if applicable) remaining wiring.
11. Remove and relocate wiring, devices, conduit, etc. that conflict with construction related work of other trades as necessary to accommodate new work of respective trade.
12. Provide electrical disconnections, and reconnections where applicable, for equipment to be removed (or relocated) by other trades.

13. Refer to Owner’s Representative for disposal instructions for abandoned electrical materials removed during demolition and thereafter. Neatly store electrical materials that the Owner elects to retain at the site as designated by the Owner's Representative. Legally dispose of materials that the Owner elects not to retain.
14. Disconnect and remove electrical materials designated for salvage (removal and reuse, or for turning over to Owner) undamaged. Disconnect and remove wiring and "whips" from equipment terminal points.
15. Clean components to be reused inside and out, and reinstall where indicated on drawings. Modify and extend related existing wiring in conduit accordingly.
16. Carefully transport salvaged electrical materials to a protected on-site storage location as directed in field and neatly store them grouped by system type.

END OF SECTION 260505

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of conductor and cable.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below, or by an NRTL listed equivalent manufacturer.

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.
7. American Insulated Wire Corp
8. Republic Wire

B. Conductor Insulation and Multiconductor Cables: Comply with NEMA WC 70/ICEA S-95-658. Refer to Part 3 of this section for allowable types specific to this project.

2.2 CONNECTORS AND SPLICES

A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide products by one of the manufacturers listed below, or by an NRTL listed equivalent manufacturer.

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.
10. Square D, a Schnieder Electric Company
11. Thomas & Betts
12. Arrow-Hart Div, Crouse-Hinds Co

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 APPLICATIONS AND INSTALLATION

A. Feeders: Stranded copper conductors for feeders smaller than No. 1 AWG; stranded copper or stranded aluminum for feeders No. 1 AWG and larger. If aluminum is selected for feeders No. 1 AWG and larger, provide aluminum for all such feeders; do not use copper for some and aluminum for others.

B. Branch Circuits: Stranded copper conductors.

C. Where applicable for electrical equipment connections for aluminum wiring, provide the following supplemental requirements and work regardless of who furnishes the equipment or what type of equipment is affected.

1. Review equipment submittals, installation documents and nameplates to determine if there are any warranty or UL limitations regarding copper versus aluminum wiring connections at equipment.
2. If there are any limitations, provide local non-fused disconnect at or near equipment (external to the equipment) and terminate aluminum conductors to the line side terminals of the disconnect switch. Provide copper conductors from load side terminals of the disconnect switch to the respective equipment factory disconnect or terminals as applicable.
3. Provide UL-Listed AA-8000 series compact-stranded conductors with insulation type compliant with specifications, prevailing codes and end-use equipment manufacturer requirements. Provide appropriately UL-Listed connectors as recommended by conductor manufacturer. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

D. Provide conductor insulation rated at 600VAC and 90 degrees C. Provide wire, cable and connectors suitable for the temperature, conditions and location where installed. Provide THHN/THWN insulation for conductors 500 kcmil and larger, and for conductors # 8 AWG and smaller. Provide THW or THHN/THWN insulation for other sizes as appropriate for the locations where installed. Provide XHHW-2 insulation for wiring below grade and for wiring subject to moisture conditions.

E. Grounded (“Neutral”) Conductors: Provide dedicated parity sized grounded (“neutral”) conductor for each branch circuit phase conductor fed from 15-ampere and 20-ampere branch circuit breakers. Provide grounded (“neutral”) conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used. Provide grounded (“neutral”) conductor for all multi-pole feeders. Provide grounded (“neutral”) conductor(s) for all multi-pole feeders and branch circuits unless this contractor determines in field that the affected load(s) will never have need for a grounded (“neutral”) conductor and NEC does not mandate otherwise.

F. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables. Use manufacturer UL 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. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install wire in raceway unless specifically permitted otherwise in this specification section, under other Division 26 sections, or on electrical drawings. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Do not pull wire until raceways are complete, plastering is complete, and raceways are free of moisture. Install joints and splices only at NEC approved panels, accessible junction boxes, or accessible outlet boxes. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary to prevent damage to conductors. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to wire or cable. Conceal work in finished spaces.

I. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems." Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are not permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices, equipment or other electrical work.

J. Neatly dress work. Install work parallel and perpendicular to surfaces and exposed structural members, and follow surface contours where possible. Keep conductor splices to minimum. Install splice and tap connectors that possess equivalent, or better, mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors that are compatible with conductor material. Install wires continuous from outlet to outlet. Provide insulation value of joints at least 100 percent more than that of the wire insulation. Provide adequate length of conductors within electrical enclosures, and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

K. De-rate cables per NFPA 70 where bundled, where passing through insulation, and where otherwise required to be compliant with NFPA 70 based on field conditions and/or means and methods that will be used. De-rate conductors per NFPA 70 where required based on quantities of conductors within raceways, and where otherwise required to be compliant with NFPA 70 based on field conditions and/or means and methods that will be used.

L. Type MC cable may be utilized only if NEC approved and if approved by local authority having jurisdiction and if included in the limited applications defined below.

1. Provide for final connections to luminaires that are installed in accessible tile ceiling systems (limited to 6' maximum in length and limited to “whips” from building electrical system junction boxes down to luminaires). Do not install Type MC cable from fixture to fixture unless a special properly listed and labeled UL approved system is specifically indicated.

2. Provide only where concealed (install wiring for exposed applications in raceway).
3. Route cables perpendicular and parallel to the building architectural lines, surfaces, and structural members, keeping offsets to a minimum and following surface contours where possible. Maintain a uniform elevation for cable runs wherever possible. Support and anchor cables at maximum 4-foot intervals and within 12" of box or outlet in a manner that prevents sagging. Install cables in a manner that prevents overheating. Fasten cables directly to the structure using factory clamps and clips specifically designed for the respective cable (Caddy or equal).

3.2 CONNECTIONS

A. 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. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Install conductor at each outlet with at least 8 inches of slack.

B. Provide complete assembly of materials for each type of required electrical connection, including but not limited to, pressure connectors, terminal (lugs), electrical insulating tape, heat shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

C. Unless otherwise indicated, provide wires/cables (conductors) for electrical connections that match, including sizes and ratings, of wires/cables that are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 90 degrees. Provide factory splice kits (U.L. approved for submersion in water and direct burial) for wire splicing in outdoor grade, or slab on grade, junction boxes and for all other wet locations.

D. Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals, and that are recommended by equipment manufacturer for intended applications. Connect wires #6 AWG and larger to panels and apparatus by means of approved lugs or connectors large enough to enclose all strands of the conductors. Provide solderless type connectors

E. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment. Cover splices with electrical insulating material to achieve insulation at least 100 percent in excess of electrical insulation rating of those conductors being spliced. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Do not "ring" copper conductors while skinning wire.

F. There may be cases where circuit or feeder conductor sizes are too large or too small to fit into the lugs normally supplied with the power distribution equipment or end-use equipment, due to circumstances such as increasing conductor sizes to offset voltage drop, unusual breaker frame sizes, type of conductors used, etc. In such cases provide appropriate factory lug kits for affected equipment if recommended by manufacturer; elsewhere provide insulated butt-splices with tails sized to fit respective lugs.

G. Ground metal frames of portable and stationary direct-wired electrically operated equipment by connecting frames to the circuit equipment grounding conductor and to grounded metal raceway. Provide necessary electrical connections between the specified equipment and junction boxes, disconnect switches, and starters near equipment with flexible metallic conduit and matched connectors. Do not expose flexible conduit in finished areas.

3.3 CONDUCTOR SIZING

A. Conductor sizes indicated in Division 26 documents are based on copper unless specifically indicated otherwise on single-line diagram on drawings.

B. Provide minimum #12 AWG conductor size, unless specifically indicated otherwise on drawings.

C. Unless specifically indicated otherwise on drawings, provide grounded (“neutral”) conductors that are at least parity-sized with corresponding phase/line conductors for all applications.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of ground rod, bar and connection type.

1.2 QUALITY ASSURANCE

A. Provide 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. Comply with UL 467 for grounding and bonding materials and equipment. Comply with ANSI/TIA/EIA-607, “Commercial Building Grounding and Bonding Requirements for Telecommunications. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Except as otherwise indicated, provide copper electrical grounding and bonding systems and materials with assembly of materials including but not limited to cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where materials or components are not indicated, provide products that comply with NEC, UL, and IEEE requirements, and with established industry standards for those applications indicated. Utilize compatible metallic materials throughout system to eliminate galvanic action.

B. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide conductors and connectors as specified in Section 260519. Subject to being equivalent and subject to compliance with requirements, provide other grounding related materials by Erico (as a standard of quality), or other equivalent available manufacturers where not otherwise specified in Division 26.

2.2 GROUNDING BUSBARS

A. Electrical Service Entrance grounding busbar

1. Electro-tin plated ¼” thick copper bar
2. Insulated standoffs
3. Hole pattern type “CC”
4. 4 inches high x 24 inches wide
5. Standard of quality shall be equivalent to Erico Electrical Products # EGBA14424CC

2.3 CONDUCTORS AND CONNECTORS AND ELECTRODES

A. For insulated conductors, provide copper or tinned-copper wire or cable insulated (green-colored) conductors, insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction. For bare copper conductors, provide: Solid Conductors, ASTM B 3; Stranded Conductors, ASTM B 8; Tinned Conductors, ASTM B 33.

B. Provide connectors listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected. Provide copper or copper alloy bolted connectors for conductors and pipes, pressure type with at least two bolts. Provide clamp type pipe connectors, sized for pipe. Use exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Provide copper-clad steel (copper molecularly bonded to nickel-sealed high-strength steel core) ground rods, 3/4 inch in diameter by 10 feet in length (sectional rods may be used when rods are longer than 10 feet). Provide sheet copper plate electrodes that are 20-gage by 36" by 36", made from high-conductivity sheet, with cable attachments (minimum quantity of 2), sized for cables as necessary to fulfill project grounding requirements, where ground rods cannot or should not be used.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Provide green-colored insulation, unless indicated otherwise. Provide solid conductors for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated. Provide bare copper conductors below grade, No. 2/0 AWG minimum. Provide tinned conductors in corrosive areas. Where to be installed underground, bury at least 36 inches below grade.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors as required by NFPA 70 and as otherwise required. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70: all feeders; all branch circuits; expansion couplings; flexible raceway runs.

B. Air-Duct Equipment Circuits: Install 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.

C. Water Heaters: Install a separate insulated equipment grounding conductor to each water heater. Bond conductor to heater units, piping, connected equipment, and components.

3.3 INSTALLATION

A. 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.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Install bonding so vibration is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Ground Rods: Drive rods until tops are at least 2 inches (50 mm) below finished floor or final grade unless otherwise indicated. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any. For grounding electrode system, install at least three 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. Use driving sleeves or couplings when driving ground rods into the earth.

D. Ground Plates: Provide copper ground plates where ground rods cannot be used. Provide connections to ground electrodes at a point not less than 1 foot below grade level, and not less than 2 feet away from footings and foundations. Weld grounding conductors to underground grounding electrodes where mechanical connections cannot, or should not, be utilized. Interconnect ground plates with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except if otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Service Entrance Grounding Requirements

1. Provide a parity sized insulated grounded conductor (neutral) for each set of service entrance feeder phase/line conductors, terminated and bonded to service equipment (i.e. to each and every service disconnect where applicable). This applies whether or not downstream loads require a neutral conductor. Install these neutral conductors unspliced and unbroken.
2. Ground and bond service entrance neutrals to room ground busbar, to effectively grounded structural steel member, to effectively grounded metallic water pipe, and to grounding electrode system as required per NFPA 70 and as applicable.
3. Remove bonding jumpers between neutral bars and equipment ground bars for applications where new electrical power services are being provided and are “back-feeding” previously existing electrical power service equipment. Provide insulated equipment ground conductors with all such “back-feeders”.

4. Provide an enclosed single ground busbar at electrical service entrance locations, bonded to the enclosure, and bonded to service ground with full parity sized green insulated ground conductor (sized same as service ground conductor). Provide quantity and sizes of lugs on busbars as required to accommodate bonding to service grounding electrode system, service neutrals, structural steel, effectively grounded metallic water pipe, and other grounding requirements set forth in project manual and in NFPA 70. Provide UL listed lugs for use with copper and aluminum conductors.
5. Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold-water pipe at service entrance using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange. Ground electrical service system neutral at service entrance equipment to grounding electrodes. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters and water service entrance valves.
6. Contact AHJ electrical inspector in advance of installing service grounding work. Determine locally approved methods that must be used for re-bar grounding that the AHJ considers compliant with NFPA 70 Article 250.52.

H. Grounding Requirements for Adjoining and Adjacent Structures

1. This subsection applies for any building structure of any kind that adjoins another in any way, including portions of common buildings that “adjoin” via expansion joints, as well as adjacent abutting structures.
2. Bond new concrete columns using minimum #3/0 AWG below-grade copper conductors. For steel construction, bond together every other steel perimeter column to those of adjacent and adjoining structures. Provide minimum surface contact area of eight square inches, welded securely to clean areas of the steel, for structural steel bonding plates (equivalent bolting methods are acceptable only if means and methods are in strict compliance with directives obtained from the project Structural Engineer). Provide minimum #3/0 AWG copper bonding jumper between bonding plates with sufficient slack to allow for building expansion and movement. Install this work above accessible ceilings or in other accessible non-public areas.
3. Provide an earth ground at every other new column in all directions. Adjacent columns may be earth-grounded at one of the columns instead of both, at column groups that are bonded together.

3.4 LABELING

A. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed. The labels or text shall be green. Label Text: "GROUND SYSTEM - If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect, test and adjust components, assemblies, and equipment installations, including connections. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test continuity of each conductor. Test completed grounding system at service disconnect enclosure grounding terminal/bar, and at each location where a maximum ground-resistance level is specified or as required to verify integrity of grounding electrode system. Make tests at ground rods before any conductors are connected.
4. Measure and report measured ground resistances that exceed 3 ohms. If resistance to ground exceeds specified values, notify Design Professional promptly and include recommendations to reduce ground resistance. After review and comment by Design Professional, take appropriate action to reduce resistance to specified values, by driving additional ground rods or installing additional ground plates or chemically treating adjacent soil, or providing chemical ground rods or combinations thereof. Then retest to demonstrate compliance.
5. Installed components will be considered defective if it does not pass tests and inspections. Correct malfunctioning work on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new work and retest. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL (NOT USED)

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Construct with 9/16" dia. holes, nominal 2" o.c. on top surface, with standard factory finish, and with the all necessary fittings which mate and match with U-channel. Select channel dimensions for applicable load criteria. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Tube & Conduit
2. Caddy
3. Cooper B-Line, Inc.; a division of Cooper Industries
4. ERICO International Corporation
5. GS Metals Corporation
6. Hilti
7. Powers
8. Thomas & Betts Corporation
9. Unistrut; Tyco International, Ltd.
10. Wesanco, Inc.
11. Perma-Cote

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Riser clamps for supporting rigid metal conduit; galvanized steel; with 2 bolts and nuts, and 4" ears.
2. Clevis hangers: For supporting rigid metal conduit; galvanized steel; with 1/2" dia. hole for round steel rod.
3. Galvanized steel clamps; 1/2" rod size.
4. Galvanized steel clamps, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2".
5. One-hole conduit straps for supporting 3/4" rigid metal conduit; galvanized steel.
6. Two-hole conduit straps for supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
7. Offset conduit clamps for supporting rigid metal conduit; galvanized steel.

D. Support for Conductors in Vertical Conduit: 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following.

1. Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   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.
   f. Simpson Strong-Tie Co., Inc.

2. Capacities: Provide materials and installed systems with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used, plus 100% safety factor.
3. Mechanical-Expansion Anchors in Dry Conditioned Areas: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement Provide stainless steel anchors where located in areas subject to moisture or corrosion.
4. Drop-In Anchors: AISI Type 303 stainless steel, drop-in, shell or flush type, equivalent to Hilti HDI series.
5. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
6. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
7. Through Bolts: Steel structural type, hex head, and high strength. Comply with ASTM A 325.
8. Toggle Bolts: All-steel galvanized springhead type, minimum 3/16” x 4”.
9. Hanger Rods: Threaded steel, Galvanized steel rods; 1/2" minimum diameter.
10. Clevis hangers: For supporting rigid metal conduit; galvanized steel; with 1/2" minimum diameter hole for round steel rod.
11. Galvanized steel rod reducing couplings: 1/2" x 5/8” minimum.
12. Galvanized steel clamps: 1/2" minimum rod size; Galvanized steel clamps: Minimum 1-1/4" x 3/16" stock; minimum 3/8" cross bolt; minimum flange width 2".
13. Hexagon nuts: Galvanized steel.
14. Expansion anchors: Minimum 1/2".

PART 3 - EXECUTION

3.1 APPLICATIONS AND INSTALLATION

A. It shall be the responsibility of the electrical contractor to supervise the installation of and pay for all additional members, wood or metal and labor which may be required to support any type of permanent or temporary electrical apparatus employed in the execution of the electrical contractor's work. Provide supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment as required.

B. Coordinate layout and installation of equipment and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Provide supports for multiple raceways capable of supporting combined weight of supported systems and its contents, plus minimum 100% factor of safety. Provide equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components. Provide rated strengths adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

D. Locate all structural elements within concrete prior to pre-drilling anchors. Contractor is responsible for repairing all damage to structural elements resulting from the scope of this work. Anchor hole dimensions shall be per manufacturer recommendations. Drill and install anchors to depths as recommended by respective anchor manufacturer. Select and apply anchor products based on collective weight being supported, plus 100% factor of safety.

E. Comply with NECA 1 and NECA 101 for application and installation requirements of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

F. All electrically related work shall be supported directly from building structural members. Electrically related work shall not be supported from ductwork, ductwork hangers, ceiling supports, existing conduit supports, etc. Install supports with spacing's indicated and in compliance with NEC requirements, including all requirements of Article 110.26. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

G. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Field Welding: Comply with AWS D1.1/D1.1M.

H. Touchup Painting: 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. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils. For galvanized surfaces, clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

I. Install equipment and enclosures on walls with tops at uniform height unless otherwise indicated, and by bolting units to structural wall or mounting on structural-steel channels bolted to wall. For equipment and enclosures not at walls, provide freestanding structural-steel channel racks that are anchored to floor structure and overhead structure.

J. Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are not permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices, equipment or other electrical work. Provide metal clamps, clips, etc. that are manufactured for use for respective applications where they are used. Use of perforated straps is not permitted.

K. Route all conduits, raceways and cables (where applicable) parallel and perpendicular to building structural members. Any and all noncompliant work installed by the electrical contractor shall be removed and reinstalled by the electrical contractor to the satisfaction of the Owner's Representative and the Design Professionals, at the expense of the electrical contractor.

L. All fasteners, hangers and methods of hanging exposed work in finished areas shall be submitted to the Owner's Representative for review before installation. Fasteners shall be zinc-coated, type, grade, and class as required for a neat finished installation.

M. Space supports for conduits and raceways required by NFPA 70 as a minimum. Minimum rod size shall be 1/4 inch in diameter. For multiple raceways or cables, install trapeze-type supports fabricated with steel slotted, sized so capacity can be increased by at least 100 percent in future without exceeding specified design load limits. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, or single-bolt conduit clamps using spring friction action for retention in support channel as applicable.

N. Coordinate with installation of roof curbs, equipment supports, and roof penetrations as applicable. Install work so that no raceway or cable is within six inches below roof deck(s). Suspend and support overhead electrical work from roof trusses and joists/joist girders only at panel points, at top chord only, unless otherwise indicated.

O. Do not drill any concrete structural members or decks without prior case-by-case written approval of means and methods from Owner and Design Professionals.

P. Do not suspend overhead hangers, or support any other overhead electrical work, from non-poured-concrete roof decks.

Q. Support overhead hangers supported from poured-concrete decks using stainless steel threaded inserts, with approval of means and methods obtained from Owner and Design Professionals.

R. Field-verify lengths of stems, pendants, cables, suspensions, etc. for all suspended luminaires with Owner's Representative.

S. 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. or 100 percent factor of safety, whichever is greater.

T. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment. Install anchor bolts according to anchor-bolt manufacturer's written instructions. Provide female expansion anchors, and install studs and nuts after equipment is positioned. Torque bolts and nuts on studs to values recommended by equipment manufacturer. Provide bushings for floor-mounted equipment anchors to allow for resilient media between anchor bolts/studs and mounting hole in concrete. Provide anchor bolt bushing assemblies for wall-mounted equipment to allow for resilient media where equipment and equipment-mounting channels are attached to wall.

1. To Wood: Fasten with lag screws or through-bolts. Provide Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent. Provide marine grade products where

subject to moisture conditions. Provide Simpson Strong Tie (or equal) expansion screw anchors. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not 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 members. Attach to substrates as required to support applied loads.

2. To Wood Structural Members: Provide bolts installed through members.
3. To New Concrete: Provide channel-type concrete inserts and bolt to inserts, or provide expansion anchors for applications where inserts are not practical.
4. To Existing Concrete: Expansion anchor fasteners.
5. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars and other structural elements. Review proposed means, methods, locations, etc. in advance with Owner and Design Professionals.
6. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
7. To Steel: Welded threaded steel studs complying with AWS D1.1/D1.1M, with lock washers and nuts, or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, clamped to flanges of beams or on upper truss chords of bar joists.
8. To Light Steel: Sheet metal screws.
9. Items Mounted on Hollow Walls and Nonstructural Building Surfaces in finished areas: Provide blocking between studs behind finished wall surface. Mount equipment, devices and boxes with backs of enclosures flush to front of finished wall surface.
10. Items Mounted on Hollow Walls and Nonstructural Building Surfaces in unfinished areas: Mount equipment on slotted-channel racks attached to substrate.

U. Coordinate all work with all other trades prior to commencement of the work. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature.

V. Fabricated Support Devices:

1. Conform to the manufacturer’s recommendations for selection and installation of supports.
2. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
3. Support parallel runs of horizontal raceways together on trapeze-type hangers.
4. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners shall be used in lieu of hangers for 1-1/2 inches and smaller raceways above suspended ceilings only.
5. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits.
6. Support exposed and concealed raceway within 1 foot of box and access fittings. In horizontal runs, support at the box and access fittings shall be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
7. In vertical runs, arrange supports so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on the ends of the raceway.
8. Miscellaneous supports:

a. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, pull boxes, junction boxes, and other devices.
b. Support outlet boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
c. Support junction boxes, pull boxes and other boxes directly from the building structure.

9. Fastening:

a. Fasten pathway products and associated supporting hardware securely to the building structure.
b. Fasten by means of wood screws on wood, toggle bolts on hollow masonry units.
c. Fasten by means of concrete inserts or expansion bolts on concrete or solid masonry.
d. Fasten by means of bolts with lock washers and nuts, machine screws, welded threaded studs, or clamps on steel (spring-tension where applicable).
e. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.
f. In partitions of light steel construction, use sheet metal screws.
g. When installing fasteners in concrete or CMU structures, do not cut, drill or damage reinforcing bars or other structural elements.
h. Ensure that the load applied to any fasteners does not exceed 25-percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.
i. Raceway supports: Hanger spacing shall be as required for adequate support of the raceway, but in no case shall there be less than one hanger per 8 feet of raceway length.

10. Locate all structural elements within existing concrete prior to pre-drilling or setting anchors. Contractor is responsible for repairing all damage to structural elements resulting from the scope of this work.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For surface raceways, wireways, fittings, boxes, enclosures, and cabinets.

B. Shop Drawings

1. Coordination Drawings: Prior to commencing with any related work, submit routing plans drawn to scale coordinated with the other trades. Drawing(s) shall include vertical and horizontal offsets, raceways sizes, equipment clearances, structural members, etc.

C. Definitions

1. EMT: Electric metallic tubing.
2. FMC: Flexible metallic conduit.
3. GRC/RMC: Galvanized rigid steel conduit.
4. IMC: Intermediate metal conduit.
5. LFMC: Liquid-tight flexible metallic conduit.
6. RNC: Rigid nonmetallic conduit.
7. Conduit/Raceway/Pathway: “Conduit”, “raceway”, “pathway” and similar terms shall be taken to mean “conduit” unless specifically indicated otherwise in project manual documents, or unless specifically directed otherwise in field by Owner or Design Professionals. All such terms shall be considered synonymous for the general purposes of installation means and methods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Metal conduits, tubing, boxes and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Subject to compliance with requirements, manufacturers offering raceway, box and fitting related products that may be incorporated into the Work as applicable include, but are not limited to, the following:

1. Allied
2. Adalet.
3. AFC Cable Systems, Inc.
4. Allied Tube & Conduit; a Tyco International Ltd. Co.
5. Anamet Electrical, Inc.
6. Appleton Electric.
7. Armorcast Products Company
8. Arnco Corporation
9. Baxter
10. Bell Electric.

11. Bowers.
12. Cantex.
13. Carlon.
14. Carson Industries LLC
15. CDR Systems Corporation; Hubbell Power Systems
16. CertainTeed Corp.
17. Condux International, Inc.
18. Cooper
19. Eagle Electric Mfg Co., Inc.
20. Efcor.
21. EGS/Appleton Electric
22. Electri-Flex Company.
23. Erickson Electrical Equipment Company
24. FSR
25. General Electric Company
26. Highline Products
27. Hoffman; a Pentair company.
28. Hubbell.
29. Kraloy.
30. Lamson & Sessions; Carlon Electrical Products
31. LTV.
32. Midland-Ross Corp.
33. Milbank Manufacturing Co.
34. Mono-Systems, Inc.
35. NewBasis
36. Niedax-Kleinhuis USA, Inc.
37. Nordic Fiberglass, Inc
38. Norwalk
39. O-Z/Gedney; a brand of EGS Electrical Group.
40. Oldcastle Precast, Inc.; Christy Concrete Products
41. Panduit
42. Pass and Seymour, Inc.
43. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
44. Quazite
45. RACO
46. Regal.
47. Republic Conduit.
48. Robroy Industries.
49. Siemens/ITE
50. Southwire Company.
51. Spring City Electrical Manufacturing Company
52. Square D; a brand of Schneider Electric.
53. Stahlin Non-Metallic Enclosures; a division of Robroy Industries
54. Steel City.
55. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
56. Tay-Mac
57. Thepitt.
58. Thomas & Betts Corporation.
59. Walker/Wiremold/Legrand
60. Western Tube and Conduit Corporation.
61. Westinghouse/Cutler-Hammer
62. Wheatland Tube Company; a division of John Maneely Company.
63. Wiegmann (Hubbell-Wiegmann)

2.2 METAL CONDUITS, TUBING, AND FITTINGS

A. EMT: Comply with FS WW-C-563, ANSI C80.3 and UL 797.

B. IMC: Comply with ANSI C80.6 and UL 1242.

C. GRC/RMC: Comply with ANSI C80.1 and UL 6. Provide steel conduit, galvanized/fused to inside and outside walls of conduit and fittings after fabrication and after threading.

D. FMC: Comply with FS WW-C-566 and UL 1; zinc-coated steel. Provide flexible metal conduit formed from continuous length of spirally wound, interlocked zinc-coated or galvanized (inside & outside) strip steel. Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type, with insulated throats. Provide Straight Terminal Connectors consisting of one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end with locknut. Do not use 45-degree or 90-degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction. Provide full size green insulated ground wire for all applications, regardless of length.

E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

1. Provide liquid-tight flexible metal conduit formed from continuous length of spirally wound, interlocked, double-wrapped hot-dipped zinc-galvanized (inside & outside) steel core. Provide liquid-tight jacket of flexible polyvinyl chloride (PVC) that is fully weatherproof, flame-retardant, heat resistant, oil resistant, sunlight resistant and that resists heat, oil and chemical breakdown.
2. Provide smooth-wall type jackets (not a corrugated look) for furniture whip (and similar) applications in indoor finished areas.
3. Provide Liquid-Tight Flexible Metal Conduit Fittings compliant with FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.
4. Provide Straight Terminal Connectors that are one-piece body, female ends with clamps and deep slotted machine screws for securing conduits, and male threaded ends with locknuts.
5. Provide Terminal Angle Connectors that are 45-degree or 90-degree two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut. Do not use 45-degree or 90-degree Terminal Angle Connectors for flexible or water-tight flexible metal conduit in locations that will not be fully accessible after completion of construction.
6. Provide full parity size green insulated ground wire for all applications, regardless of length.
7. Provide installed LFMC systems using materials and installation methods that result in IP67 compliant.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. EMT: Provide steel, galvanized or zinc-coated water/concrete-tight fittings; do not use die-cast fittings. Provide Compression type for outdoor applications, and applications in other wet locations. Provide Compression or set screw type for indoor applications.

2. GRC/RMC: Zinc-Galvanized Steel (after fabrication/factory-threading), threaded (fused-galvanized after threading.)
3. Expansion Fittings: Material to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Provide terminal conduit fittings with insulated throats, or plastic bushings for conduits 2" and larger where insulated throats may not be not readily available.
5. Provide locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening. Provide screw type grounding terminal for metal bushings of standard or insulated type.
6. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that are specifically designed for their particular application.
7. Provide galvanized cast-metal (steel) conduit bodies of types, shapes and sizes as required to fulfill job requirements and NFPA 70 requirements. Construct conduit bodies with threaded-conduit-entrance ends, with removable covers, either cast or of galvanized steel, and with corrosion-resistant screws.

G. Joint Compound for Threaded Conduit: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Metal Product Description: Provide sheet metal wireways, complying with UL 870 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications unless otherwise indicated, and sized according to NFPA 70. Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

1. Provide screw-cover type for indoor applications, and flanged-and-gasketed type for outdoor applications unless otherwise indicated. Provide manufacturer's standard enamel finish. Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Provide plate-finished hardware to prevent corrosion. Protect screws installed toward inside of wireway, with spring nuts to prevent wire insulation damage.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Provide electrical wireways of types, grades, sizes, and number of channels for each type of applicable service.
3. Provide lay-in wireways with hinged covers in accordance with UL 870, and with components UL-listed, including lengths, connectors, and fittings. Provide units that allow fastening of hinged cover closed without use of parts other than standard lengths, fittings and connectors. Provide units capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts. Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature. Provide NEMA 3R units where used outdoors or in areas subject to moisture.

B. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by the Design Professional or Prime coated, ready for field painting, Design Professional's choice. Provide factory fittings, dividers, clips, and other accessories as required for a neatly installed complete and operable installation. Provide factory-applied finish in color(s) and texture(s) as directed by Design professionals.

1. One-Piece Surface Raceway Systems: Provide surface metal raceways equal to Wiremold #V500 series (nominal 3/4 inch wide by 17/32 inch deep), or Wiremold #V700 series (nominal 3/4 inch wide by 21/32 inch deep), as necessary to accommodate NFPA 70 required raceway wire fill allowances.

B. Surface Nonmetallic Raceways: Two or three piece construction, complying with UL 5A, and manufactured of rigid. Comply with UL 94 V-0 requirements for self-extinguishing characteristics. Coordinate product requirements with HVAC contractor. Nonmetallic raceway is intended to be used for HVAC piping, as well as branch circuiting, in areas where conduit would otherwise be exposed.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be UL listed and labeled for use in wet locations, including cover plates and doors. Boxes, enclosures, and cabinets installed in damp and areas subject to moisture shall be UL listed and labeled for use in damp locations, including cover plates and doors. All other applications shall be UL listed and labeled for the location in which they are installed. Provide galvanized (after fabrication and after threading) boxes with galvanized or stainless-steel accessories, hardware and cover plates.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Provide galvanized-coated flat rolled code-gage non-gangable sheet-steel outlet/junction/pull boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides where applicable. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Provide with stainless steel nuts, bolts, screws and washers.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Only use for special applications with prior case-by-case approval from Design Professionals.

D. Luminaire Outlet Boxes: Comply with outlet box specifications above; nonadjustable, designed for attachment of luminaire weight (50 lb, minimum) plus 100 percent factor of safety. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight, including 100 percent factor of safety.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box and shall extend to the finished wall surface.

F. Bushings, knockout closures and locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

G. Device Box Dimensions: 4 inches square by 1-1/2 inches deep or 4 inches square by 2-1/8 inches deep, depending on device depths and wiring fill, with single-gang plaster/"mud" rings where only one device is being installed. Provide wider boxes for applications where more than two devices will be installed. Provide internal metal dividers where required under NFPA 70 for varying voltages, multiple circuits, etc. Gangable boxes (using multiple single-gang boxes to assemble multi-gang boxes) are prohibited.

H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor applications and Type 3R for outdoor applications with continuous-hinge cover with flush latch unless otherwise indicated, and with steel interior panels that are finished with manufacturer's standard enamel.

1. Metal Enclosures: Stainless steel, or galvanized (after fabrication) steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:

1. Provide NEMA 250, stainless steel or Type 3R galvanized (after fabrication) steel boxes with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Provide hinged door in front cover with flush stainless-steel latch and concealed stainless-steel hinge. Provide key latch to match panelboards. Provide metal barriers to separate wiring of different systems and voltage. Provide accessory feet where required for freestanding equipment. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, listed by a qualified testing agency, and marked for intended location and application.

J. Weathertight outlet boxes and covers:

1. Provide corrosion-resistant weathertight/raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.
2. Provide weatherproof covers that mount on a single gang horizontal or vertical (depending on application) junction box to ensure weather protection for a standard outlet. Provide covers that can mount on indoor or outdoor junction boxes and that include a weatherproof cover/base assembly with gasket, two universal inserts, and mounting hardware. Provide weatherproof cover that provides flexibility in installation. Provide covers that meet or exceed UL requirements for wet locations while in use, that meet requirements of NFPA 70 Article 410-57(b), and are minimum NEMA 3R rated. Provide weatherproof cover constructed of UV stabilized high impact polycarbonate material. Provide clear cover for the part that encloses the cord set, to allow visual inspection. Provide cover that meets agency requirements for cold impact at negative 60 degrees Fahrenheit (negative 51 degrees C). Provide covers with useable inside depth to accommodate plug head. Provide assemblies for outdoor applications, unless indicated

otherwise on drawings, and for indoor applications that serve permanent or extended-use cord & plug load connected equipment.

3. Provide minimal profile assemblies that are rated NEMA 3R While In Use and that employ recessed box and cover design, equal to Thomas & Betts “Red Dot” series. Provide trim color(s) to match surrounding finished wall surface.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: GRC/RMC or IMC.
2. Exposed and Subject to Physical Damage: GRC/RMC or IMC. Raceway locations include the following:

    a. Areas where driven/ridden mechanized equipment is operated

3. Concealed Conduit, Aboveground in Dry and Noncorrosive Locations Not Subject to Physical Damage: EMT.
4. Concealed Conduit, Aboveground in Damp Locations, Wet Locations, Corrosive Locations, Where Not Subject to Physical Damage: IMC.
5. Concealed Conduit, Aboveground in Damp Locations, Wet Locations, Corrosive Locations, Where Subject to Physical Damage: GRC/RMC.
6. Underground Conduit For Services, Feeders and Similar Scale Work : RNC, Type EPC-40-PVC. See details and/or notes on drawings for applications where concrete or other encasement is required.
7. Connection to Vibrating Equipment or equipment that is subject to any degree of motion in its normal operation (Including But Not Limited To Transformers, Electric Solenoids, and Motor-Driven Equipment): LFMC. Leave sufficient slack in flexible conduit to permit movement from vibration without adversely affecting conduits and connections.
8. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Minor Physical Damage: EMT.
3. Exposed and Subject to Moderate Physical Damage: GRC/RMC or IMC. Raceway locations include the following:

    a. Mechanical rooms
    b. Gymnasiums

4. Concealed in Cavities of Ceilings and Interior Walls and Partitions: EMT.
5. Above-Grade Damp or Wet Locations: GRC/RMC or IMC.
6. Embedded in Concrete or Masonry: GRC/RMC.
7. Final 72 inches from accessible outlet/junction boxes to recessed luminaires that are located in accessible ceiling systems: FMC (or Type MC cable).
8. Final 24-72 Inches at Connections to Vibrating Equipment or equipment that is subject to any degree of motion in its normal operation (Including But Not Limited To Transformers, Electric Solenoids, and Motor-Driven Equipment): FMC, except use LFMC in damp, wet

or otherwise corrosive locations. Leave sufficient slack in flexible conduit to permit movement from vibration without adversely affecting conduits and connections.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Raceway Fittings: Compatible with (Listed accordingly) raceways and suitable for use and location.

1. EMT: Comply with NEMA FB 2.10 and with requirements of these specifications.
2. GRC/RMC and IMC: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

A. General Installation.

1. Minimum Raceway Size: 3/4-inch trade size.
2. Install wire in raceway/conduit unless specifically permitted otherwise elsewhere in Division 26 sections, or on drawings.
3. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature.
4. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for Conduits and raceways required by NFPA 70 as a minimum.
5. Layout all proposed raceway routing, elevations, installation methods, etc. on coordination drawings and coordinate all proposed raceway routing with all affected trades prior to commencing with work. In addition, review the information with Owner and Design Professionals for all areas where the raceways will be visible after completion of construction, to ensure a neatly organized installation occurs. Where raceways must be exposed in finished/regularly occupied areas, install them in a manner that minimizes detrimental effects on room aesthetics. Install so raceways are as out of site as reasonably possible. For instance, where applicable for exposed work and if so directed by the Design Professionals or the Owner, make drops near corners, window casings, door casings, etc. Likewise, if a receptacle needs to be installed at the center of a wall, install the raceway down the wall in a corner of the room then transition and run horizontally to the outlet location if so directed by the Design Professional or the Owner. Use compression fittings for EMT applications in these areas. Do not use strut or fasteners that stand off from wall for wall applications in these areas. Install exposed wall-mounted conduits tight to wall using one-hole straps for conduits 1-1/4 inches and smaller, and use two-hole straps for conduits 1-1/2 inches and larger.
6. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
7. Do not install aluminum products in contact with, or near proximity to, concrete or earth.
8. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
9. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.
10. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
11. Locate all structural elements within concrete prior to pre-drilling anchors. Contractor is responsible for repairing all damage to structural elements resulting from the scope of this work.

12. Provide fittings as needed for a complete installation. Provide locknuts for securing conduit to enclosures with ridged outside circumference for proper fastening. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that are specifically designed and intended for their particular application.
13. Provide knockout closures to cap unused knockout holes where blanks have been removed.
14. Provide flexible connections or expansion fittings where all conduits cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of work.
15. Install electrical boxes in those locations that ensure accessibility to enclosed electrical wiring.
16. Do not install boxes back-to-back in walls. Provide not less than 6" (150 mm) separation in general, not less than 16” separation for acoustically rated walls and not less than 24" separation for the following applications: fire walls, fire barriers, smoke barrier walls, and fire partitions. Where outlet boxes are shown back-to-back on common walls, offset accordingly when installed.
17. Fire walls, fire barriers, smoke barrier walls and fire partitions: Steel outlet boxes that do not exceed 16 square inches in area may be used in fire walls, fire barriers, smoke barrier walls, and fire partitions only if the total area of such openings does not exceed 100 square inches for any 100 square feet of wall area. Verify with local authorities having jurisdiction prior to commencing with related rough-in work. Provide outlet boxes, equipment back-boxes, etc. in fire walls, fire barriers, smoke barrier walls, and fire partitions that are of the type tested for use in fire-resistance-rated assemblies. Install in accordance with the tested assembly, and with the instructions included in the listing. Install firestopping at penetrations of fire-rated floor and wall assemblies.
18. Neatly cut openings for boxes so that standard size (not "midway" or "jumbo") cover plates will cover all parts of the opening. Position recessed outlet boxes accurately to allow for surface finish thickness. Do not use round boxes.
19. Fasten electrical boxes firmly and rigidly to substrates and structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry as applicable. Provide box supports that are independent of conduit. Protect boxes from construction debris and damage subsequent to installation of boxes.
20. Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are not permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices, equipment or other electrical work. Do not use perforated straps.
21. Consider the outlet, junction, and pull box locations indicated on drawings approximate unless there are prevailing codes that require specific spacings or locations. Study the general construction with relation to spaces and equipment surrounding each outlet, and neatly install outlets accordingly.
22. Install wiring for different power voltages in raceway systems separate from each other. Install wiring for the various electrical systems in raceway systems that are separate from each other.
23. Provide steel conduit and steel fittings for indoor above-slab applications, as specified in this section.
24. Provide conduit fittings with insulated throats. Plastic bushings may be used for conduits 2" and larger where insulated throats may not be readily available.
25. Provide maximum of 40 percent fill for raceways, or a threshold of less if required by NFPA 70 or project conditions.
26. Keep raceways at least 12 inches away from parallel runs of flues, hot-water pipes, and other sources of heat. Install horizontal raceway runs above liquid and steam piping. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
27. Support risers at each floor level with suitable hangers.

28. Level and square raceway runs, and install at proper elevations and heights.
29. Protect coatings, finishes, and cabinets from damage and deterioration. Repair damage to galvanized finishes with zinc-rich paint or coating, color to match surface, recommended by manufacturer. Make these repairs prior to products receiving finish coats of paint.
30. Pathway Evacuation and Protection: Cap and plug conduit ends with standard accessories as soon as conduit has been permanently installed. Prior to the installation of cable, clean and vacuum boxes, conduits/raceways, supports, etc. Clean inside of conduit before wiring is pulled. Remove solids or other hindrances that could impede its full utilization or that could damage cable during or after installation. Remove liquid and moisture from the raceways. Blow out until raceway is dry, sufficiently that the installed cables will not be subjected to any contact with fluid or moisture. Seal and protect raceways and boxes from moisture infiltration. Provide watertight fittings. Do not begin installation of conductors and cables until electrical raceways are complete and until installation locations (end to end) are in a weatherproof environment.
31. Arrange stub-ups so curved portions of bends are not visible above finished grade or slab.
32. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12 inches of changes in direction.
33. Support conduit within 12 inches of enclosures to which attached. Properly support and anchor raceways for their entire length using structural materials. Do not span any space unsupported.
34. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
35. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits. Fasten conduit terminations in sheet metal enclosures with two locknuts. Install locknuts inside and outside enclosure.
36. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
37. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
38. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Field-bend conduits with benders designed for purpose so as not to distort, nor vary, internal diameters. Bring joints to a shoulder. Provide suitable supports and fasteners for conduit.
39. Conceal conduit and tubing within finished walls, ceilings, and floor cavities unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
40. Install exposed conduits, and extensions from concealed conduit systems, neatly parallel and perpendicular to walls, and plumb on walls. Secure to walls at intervals not exceeding six feet, supported by approved straps and fasteners. Secure to overhead structure at intervals not exceeding six feet. Support conduit by approved straps, fasteners and hangers. Provide hangers suspended from rods. Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Install exposed conduit work so there is no interference with ceiling inserts, lights, or ventilation ducts or outlets.
41. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use, using properly selected and attached manufactured cap (tape of any sort is not permissible). Provide finished wall/cover plate on unused outlet boxes.

42. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
43. Mount boxes at heights indicated on Drawings and elsewhere in Division 26 specifications. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated. In cases where using center of box for measurement would result in a switch-height device having an operable component higher than 48 inches above finished floor, install boxes lower as needed so that uppermost part of operable component is no higher than 48 inches.
44. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block (do not over-cut), and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
45. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Coordinate all such separations with Design Professional in advance to ensure boxes are located properly for each application.
46. Locate boxes so that cover or plate will not span different building finishes.
47. Support boxes from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
48. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
49. Provide properly wired electrical connections within enclosures. Anchor enclosures ensuring that they are level, and permanently and mechanically secure.
50. Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for applications as needed to render electrical work fully operational.
51. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrically conducting equipment grounding path. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly. Conduit shall be continuous between outlets to make a complete installation and to provide a continuous ground.
52. Do not use dissimilar metals throughout the systems to eliminate possibility of electrolysis. Where dissimilar metals will be unavoidably in contact, coat surfaces with corrosion inhibiting compound before assembling.
53. Use rough-in dimensions of electrically operated equipment furnished by equipment installer. Install conduit and boxes for connection to equipment only after reviewing respective equipment and clearance dimensions, and after coordinating with other trades.
54. Do not use electrical "handy/handee" boxes.
55. Do not use running threads at conduit joints and terminations - use 3-piece union, or split coupling.
56. Provide joints made tight with water-tight couplings matching conduit. Install offsets with long radius sweep bends, except conduit sizes 1 inch and over where standard elbows may be used.
57. Where moisture conditions within conduits are encountered above grade, drill a hole at the lowest point in the conduit run so that drainage will not interfere with conditions below.
58. Where conduit is capped at wall for future additions, do not extend more than threads-length past wall (maximum of 3/4-inch past wall for EMT).
59. Where conduits for outlets on waterproof walls must be installed exposed, set anchors for supporting conduit on waterproof wall in waterproof cement.
60. Requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.
61. Provide a 4-inch reinforced casing of concrete (3000-PSI minimum) around conduits that are installed in cinders or cinder concrete, to protect them.

62. Support raceway components directly from structural building systems, not from ceiling suspensions systems. Provide supplemental supports for junction or pull boxes.
63. Support single conduits 1-1/2 inches and larger by means of rod and ring hangers. Support multiple runs in similar manner or use a common trapeze hanger system.
64. Pinch type hangers similar to Minerallac may only be used at heights greater than 8 feet, and only in unfinished areas where the work could be installed concealed.
65. Protect conduits during construction with temporary plugs or caps. Securely cap conduits until pull string, or cable is installed.
66. Conduit Routing: If specific routing information appears on the Drawings, route and maintain conduits as shown. Should interference or a conflict arise, consult the Design Professional before proceeding with the Work. If specific routing information does not appear on the Drawings, or if routing shown on Drawings is schematic in nature, determine the best route for the conduit in accordance with code and other project guidelines.
67. Conduit bends: Bends shall be made so that the conduit will not be flattened or kinked and so that the internal diameter of the conduit is not reduced. The radius of the curve of the inner edge of any bend shall not be less than indicated by the National Electrical Code and TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces. In no case shall any conduit be bent or shall any fabricated elbow be applied to a conduit that will impose less than the minimum allowable bending radius specified by the manufacturer of cable that will be installed within the conduit. When it is necessary to make field bends, use tools manufactured for conduit bending. Heating of metallic conduit to facilitate bending is not permitted. Constructing an outside entrance to a building from buried conduit to penetrate above the ceiling line will allow an exception for a 4 inches LB fitting at one end to allow placement of the conduit flat to the building outside wall; apply this only if conduit could not be concelaed.
68. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
69. Install above-ceiling conduits as high as possible, with a minimum of 8 inches above ceiling tiles so as to permit ceiling tile removal.
70. Provide flashing and counter flashing or pitch pockets for waterproofing of raceways, outlets and fittings that must penetrate the roof. Coordinate all related work with roofing installer and provide means and methods based on roofing installers recommendations.
71. Provide sleeves and sleeve seals at penetrations of exterior floor and wall assemblies, at penetrations of abutted perimeter walls for building expansions/additions, and where expansion joints are used at walls. Provide oversized sleeves in forms for new concrete walls, floor slabs, and partitions to allow for the passage of raceways. Provide waterproof sleeved raceways below grade and in areas prone to high moisture and condensation. Provide sleeves in member for conduits passing through structural members.
72. Install each branch of power in separate raceways from each other.
73. Do not install conduit horizontally in concrete slabs on grade. Do not install or embed conduits horizontally within any other slabs.
74. Do not install branch circuit conduits beneath slabs on grade, except where specifically indicated otherwise on drawings, or unless special case by case permission is obtained from Owner’s Representative in the field.

B. Stub-ups To Above Accessible Ceilings (TAAC):

1. Use EMT, IMC, or GRC/RMC for raceways as applicable for respective locations.
2. Provide sweep bends and drag line for each application.
3. Use a conduit bushing or insulated-throat fitting to terminate stub-ups.
4. Extend conduits to joist space above an accessible ceiling system.

5. Permanently identify the purpose of the conduit stub at the end of the conduit above the ceiling.

C. Pull Boxes and Junction Boxes:

1. Provide each pull box indicated on the Drawings.
2. Provide additional pull boxes: Every 180 degrees of raceway bend; Every 100 feet of raceway; As additionally required by Code.
3. Provide pull and junction boxes in areas that will be accessible after installation. Accessible areas include spaces above removable tile ceilings and behind access doors that are installed expressly for this purpose. Do not install pull-boxes in locations that will not be accessible after construction is complete and is not accessible after permanently installed work is complete.
4. Size boxes in accordance with the NFPA 70 (NEC). Use larger boxes where so specified.
5. Support boxes rigidly. Land conduits on the boxes so that conduits enter and exit across from each other on opposite sides of the box so as to facilitate straight line pulling of cable through the box. Do not use pull boxes in lieu of conduit bends, except as necessary by design or to meet constructability constraints.
6. When directional transition of the cables is necessary through a box, land conduits on the box so that they permit the largest possible bending radius for those cables that will pass through the box.
7. Coordinate all work with all other trades prior to commencement of the work. Do not use access doors unless special prior written permission is granted from the Owner’s Representative. Install pull boxes, junction boxes, etc. in areas that are accessible after construction. Do not install pull boxes or junction boxes above gypsum board, plaster or similar ceiling systems, nor above ductwork or equipment that renders them inaccessible.
8. Record junction and pull boxes on record drawings. Permanently mark and label (using methods approved by Owner's Representative) junction/pullboxes as to which types of electrical services are within.

D. Repair and Patching: Holes and other penetrations into building surfaces or structure that are created to facilitate pathway installation but that are not ultimately used shall be filled, repaired, and restored to their original strength, appearance and integrity. Damage to building or property that occurs during the course of pathway installation shall be repaired and restored to its original condition prior to damage. Obtain review and approval of penetration sizes, means and methods from Design Professional and Owner’s Representative for all proposed penetrations of structural elements prior to commencing with any related work.

E. Cover Plates: Provide gasketed stainless steel or post-fabrication hot-dipped galvanized steel cover plates over the openings of junction boxes and pull boxes. Provide blank wall plates for unused wall outlet openings, to match style and finish used for active wiring device locations in the same respective area.

F. Seals for Common Conduit and Raceways in Dissimilar Environments: Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points: Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces; Where an underground service raceway enters a building or structure; Where otherwise required by NFPA 70.

G. Insulation for Common Conduit and Raceways in Dissimilar Environments: Provide insulation on the exterior of conduit on the warm side of penetrations between dissimilar environments to prevent condensation from forming. Insulate with 1.5-inch polyisocyanurate closed cell pipe insulation with an overall PVC jacket for a minimum distance of 48” from the penetration. Applications include, but are not limited to, the following: Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces; Where otherwise required by NFPA 70.

H. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement, and for transformers and motors. Use LFMC in damp or wet locations.

I. Expansion-Joint Fittings:

1. Provide UL listed and labeled expansion fittings and appropriate couplings in metal raceways wherever structural expansion joints are crossed, wherever deflection is expected, where environmental temperature change may exceed 100 deg F with straight-run lengths that exceeds 100 feet, and as otherwise required to accommodate similar movement. Provide expansion fittings with ground bonding jumpers that are long enough to accommodate respective expansions and movement.
2. Provide expansion fittings with ground bonding jumpers that are long enough to accommodate respective expansions and movement. Install in each run of aboveground EMT, GRC/RMC and IMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
3. Install type and quantity of fittings that accommodate temperature changes of 155 deg F.
4. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
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. Install conduit supports to allow for expansion movement.
6. Type LFMC conduit may be used instead of expansion fittings in unfinished areas, using lengths of at least two (2) feet and no more than six (6) feet. Provide bonding jumpers.
7. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits.

3.3 INSTALLATION OF EXPOSED CONDUIT/RACEWAY SYSTEMS

A. General:

1. Review proposed installation materials, methods, routing, etc. case-by-case and area-by-area for each application with the Design Professional and Owner prior to installation. Accordingly, prepare installation drawings and submit to Design Professionals for review and comment. Revise and resubmit as required based on comments from Design Professionals. Coordinate with all trades while preparing the installation drawings. Show elevations and routes relative to adjacent work of all trades.
2. Group conduits together in tight banks when routed in the same direction in a given space. Coordinate with mechanical trades and route the conduit banks along common paths wherever possible, and at common elevations unless the conduit banks can be

installed directly above or below the mechanical work. Review proposed routes and elevations with Design Professionals prior to installation.

3. Install conduits that peel off from banks in a manner that results in the conduits being progressively taken off from the sides of the banks, one at a time without crossing over or under other conduits in the bank. Rise and drop conduits at the same elevation in areas with common visibility.
4. Provide clean, tight and uniform bends and offsets for all conduits and conduit banks.
5. Route overhead work perpendicular and parallel to architectural and structural building lines in the respective surrounding space. Do not install work below skylight assemblies or in front of clerestory window assemblies.
6. Provide surface conduit and raceway for wall-mounted applications only where it is impossible to fish or cut/patch, or only where specifically indicated on drawings, or only where specifically directed by Design Professional. Improper sequencing of work at walls shall not be used as a reason to surface-mount conduit, boxes or raceways; install all such work concealed as the walls are constructed. Provide conduit in areas that are exclusively utilitarian, such as dedicated mechanical or electrical rooms. Provide finished surface raceway systems for applications in all other areas. Consult with Design Professionals in advance of any installation for final direction on where to use conduit versus surface raceway systems.
7. Install conduits and raceways in a manner that minimizes detrimental effects on room aesthetics. For instance, as applicable, rise from below for wall switches, general receptacle outlets and communications wall outlets; drop from above for wall mounted lights, and other system outlets that are installed high on wall; make drops near corners, window casings, door casings, etc.).
8. Install conduits and raceways as out-of-site as reasonably possible. For instance if an receptacle outlet needs to be installed at the center of a wall and there is no possibility of feeding from below the floor, route the drop in a corner of the room then transition and run horizontally to the outlet location.
9. Install conduit and raceway with a minimum 2-inch radius control at bend points.
10. Secure conduit and raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight section. Support according to manufacturer's written instructions.
11. Utilize supports for wall-mounted applications that cleanly conform to the shape of the conduit or raceway and do not in any way protrude out past the outer contours of the conduit or raceway. As an example, install wall-mounted conduit using two-hole straps instead of conduit hangers. Tape, glue, tie-wraps, clips, wedges, etc. are not acceptable support methods.
12. Review all proposed mounting means and methods with Design Professionals for luminaires, devices, outlets, equipment, etc. that will be suspended overhead.
13. Do not use “trapeze” mounting methods for suspensions unless case-by-case permission is granted by Design Professionals.

3.4 INSTALLATION OF EXPOSED CONDUIT OUTDOORS

A. Only install conduit exposed outdoors when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed at outdoor locations, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide colors to match respective surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

3.5 INSTALLATION OF EXPOSED CONDUIT ON ROOFS

A. Only install conduit exposed on rooftops when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed on rooftops, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide white paint on flat rooftops that have finishes white in color, and for otherwise-colored roof finishes that are not visible from the building interior or from the ground outdoors. Elsewhere select colors to match surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

3.6 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Coordinate trench locations in reference to other underground utilities. Ensure no other utilities are placed directly above or below, when parallel to conduits.
2. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
3. Excavate trench bottom to provide firm and uniform support for conduit. Also see details and/or notes on drawings for additional trench-related information and for applications where concrete (or other) encasement is required.
4. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
5. Install manufactured RNC duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Provide GRC/RMC for risers, beginning below grade or slab and excluding the 90 degree fittings that connect to horizontal conduits below grade or slab, to above grade and slab except where terminating at utility poles, in utility pad-mounted transformer enclosures and cable pits, and in utility company pedestals. Couple GRC/RMC conduits to RNC ducts with adapters designed for this purpose.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."
7. Provide underground conduits at minimum of 24" below grade, slab or pavement as applicable (deeper where required by local utility company or prevailing codes and regulations), securely mounted on chairs when banked, with base in newly disturbed earth. Properly align ducts on chairs before backfilling. Provide heavy nylon pull-cord/drag-line (200 pound minimum strength) in empty conduits. Do not embed in slabs or pavement. Do not “scratch-in” just below slab or pavement.
8. Make changes in direction of raceway run with proper fittings that match raceway manufacturer.
9. Properly support and anchor raceways for their entire length with factory bases and intermediate spacers. Provide spacers at each coupling location, at each termination location, and at maximum five foot intervals between. Do not span any space unsupported. Provide end bells with rounded pulling surfaces at manholes, pull boxes and other end points of underground raceways.

10. Apply corrosion inhibiting compound before couplings are assembled for applications where metallic raceways are installed underground, in floors below grade, or outside. Draw up couplings and conduits sufficiently tight to ensure water-tightness. Provide steel rigid metallic conduit for applications where metallic conduits are installed below grade or slab.
11. Extend underground conduits that are capped at wall for future additions five feet beyond building.
12. Arrange excavation for exterior conduits so that:

    a. The lines are straight and true
    b. Grades required for drainage are maintained
    c. The tops of buried raceways are not less than 24" below finished grade

13. Seal PVC joints with product equivalent to Carlon Cement. Make solvent cemented joints in accordance with recommendations of manufacturer.
14. Install work in accordance with NFPA 70 and in compliance with local utility practices.
15. Provide full parity size green insulated ground wire in PVC runs, except for those used exclusively for optical fiber cables.
16. Do not field bend raceway sections, unless required radius exceeds that available from manufacturer. Where field bends cannot be avoided, use factory kit to perform the bends and follow factory instructions.
17. Encasement: See details and/or notes on drawings for applications where encasement is required.
18. Pressure or vacuum test below-grade conduits before and after concealing the conduits to ensure resistance to moisture ingress.

3.7 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Install so cover surfaces will be flush with finished grade or pavement as applicable. Install service/feeder scale handholes with bottom below frost line below grade. Field-cut openings for conduits in closed-bottom units and in walls of units according to enclosure manufacturer's written instructions. Cut enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Comply with ANSI A13.1(and IEEE C2 as or if applicable). Comply with NFPA 70. Comply with 29 CFR 1910.144 and 29 CFR 1910.145. Comply with ANSI Z535.4 for safety signs and labels. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways: Provide black letters on an orange field, and indicate voltage.

C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Vinyl Labels for Empty “Spare” conduits: Provide labels with description of purpose, and location of opposite end, on each end of conduits provided for future.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size. Provide black letters on orange field for cables carrying circuits at 600 V and Less, and provide legend that indicates voltage.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label. Provide preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

2.3 CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (where permitted by NEC for large feeder and sub-feeder conductors).

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed using indelible process.

2.5 SELF-ADHESIVE LABELS

A. 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, installed level and plumb.

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes, installed level and plumb.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT AND FIELD NAMEPLATE IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting, black letters on a white background for normal applications, minimum letter height shall be 3/8 inch, installed level and plumb. Provide 1/16" thickness for units up to 20 sq. in. or 8" length; provide 1/8" thickness for larger units.

B. Provide white letters on a black background for normal power distribution system equipment.

2.8 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Arc-Flash Hazard Warning Labels: Provide pre-printed “as-built” labels on power distribution and like equipment to warn of potential electric arc flash hazard. Provide in compliance with Article 110.16 of NFPA 70.

C. Warning labels and signs shall also 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 for 0-150 volts to ground equipment: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. Workspace Clearance Warning for 151-600 volts to ground equipment: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES."

2.9 FIELD IDENTIFICATION LABELS

A. Identification of Disconnecting Means: Provide pre-printed “as-built” nameplate identification labels at all service equipment to indicate the maximum available fault current. Provide in compliance with Article 110.24 (A) of NFPA 70.

B. Available Fault Current: Provide pre-printed “as-built” nameplate identification labels at each piece of power distribution equipment, each disconnecting means, etc. to indicate its purpose. Provide in compliance with Article 110.22 (A) of NFPA 70.

C. Circuit Directory/Identification: Provide pre-printed “as-built” identification at circuit sources, using directory cards intended for the purpose, for all circuits. Provide in compliance with Article 408.4 (A) of NFPA 70.

D. Source of Supply Identification: Provide pre-printed typewritten “as-built” nameplate identification labels at all electrical power distribution equipment that specifically indicates the exact source of the power supply that serves the respective equipment. Provide in compliance with Article 408.4 (B) of NFPA 70.

E. In addition to other labelling required herein or by NFPA 70, provide pre-printed “as-built” identification of the following at all service entrance equipment.

1. Potential Electric Arc Flash Hazards compliant with Article 110.16(A) of NFPA 70.
2. Nominal System Voltage.
3. Single-Phase, Three-Phase/Three-Wire or Three-Phase/Four-Wire as applicable.
4. Available fault Current at Overcurrent Protective Devices.
5. The Clearing Time of Service Overcurrent Protective Devices based on the available fault current at the service equipment.
6. The Date that the label was applied.

2.10 CABLE TIES

A. UV-Stabilized Cable Ties

1. Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
2. Minimum Width: 3/16 inch.
3. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
4. Temperature Range: Minus 40 to plus 185 deg F.
5. Color: Black.

B. Plenum-Rated Cable Ties

1. Self -extinguishing, UV stabilized, one piece, self locking.
2. Minimum Width: 3/16 inch.
3. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
4. UL 94 Flame Rating: 94V-0.
5. Temperature Range: Minus 50 to plus 284 deg F.
6. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify final operational and as-built identity of each item before installing identification products. All equipment & system identification nomenclature shown on drawings and listed herein may be shown for general design and installation reference only. Field-verify the actual nomenclature prior to fabrication. Prepare record documents accordingly. Unless determined otherwise in field, provide text matching terminology and numbering of the contract documents.

B. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. No labeling is required for raceways with readily identifiable terminations within the same room.

C. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

D. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied. Coordinate installation of identifying devices with location of access panels and doors. Install identifying devices before installing acoustical ceilings and similar concealment.

E. Apply identification devices to surfaces that require finish after finish work is complete. Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding 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-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Cable Ties: For attaching tags. Cut off excess lengths after installing ties. Use general-purpose type, except the following: Outdoors, UV-stabilized nylon; Indoors: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or envelope/encasement exceeds 16 inches overall. Install line marker for every buried cable, regardless of whether direct-buried or installed in conduit.

J. In accessible ceiling spaces and where exposed in unfinished areas, label conduit with panel and circuit numbers of conductors routed through the conduit. Label conduit at all wall penetrations and connections to all panels, junction boxes, and equipment served.

3.2 IDENTIFICATION DEFINITION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less: Identify with self-adhesive vinyl label. Locate at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas. Do not install in finished occupied areas.

B. Accessible Raceways and Cables within Buildings: Identify raceways, cables. junction and pull boxes of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows: Power.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, and handholes, use color-coding to identify the phase. Color shall be factory applied to conductor insulation or field applied for sizes No. 4 AWG and larger, if authorities having jurisdiction permit. These colors apply for factory-assembled cables as well as for individual insulated conductors. Use colors listed below for conductors.

1. Colors for 208/120-V Circuits:

   a. Phase A: Black
   b. Phase B: Red
   c. Phase C: Blue
   d. Neutral: White

2. Color for Equipment Grounding: Green
3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Conductor and Cable Supplemental Identification in Damp Locations, Wet Locations and Below Grade, 600 V or less: Use metal tags. Provide correct identification on conductors and cables installed in manholes, grade mounted junction boxes, handholes, and similar damp and wet locations. Provide tag in each location with not less than two tags per cable, one near each

conduit/duct through which the cable enters and leaves the hole. Attach tags immediately after cable is installed. Mark the tags to contain an abbreviation of the name of the system/facility served by the cable. Field verify identification nomenclature prior to fabrication of tags. Attach tags in strict accordance with manufacturer's recommendations. The identification described below is shown for schematic purposes only.

1. "6" 100V to 600V Power
2. "P" Power
3. "A,B,C,N" Phases and Neutral

E. Install instructional signs including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes, or self-adhesive, self-laminating polyester labels or self-adhesive vinyl labels with the conductor designation.

H. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

J. Locations of Underground Lines: Identify with underground-line warning tape. Install underground-line warning tape for both direct-buried cables and cables in raceway. Install detectable tape at trenches containing empty conduits and conduits containing optical fiber cable.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels. Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access. For equipment with multiple power or control sources, apply to door or cover of equipment including.

L. Operating and Warning Instruction Signs: Provide pre-manufactured operating and warning signage if indicated on drawings and where required by NEC or local authority having jurisdiction. Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at applicable equipment.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels 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, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Equipment: Self-adhesive, engraved, laminated acrylic or melamine label for normal conditioned areas, and mechanically-fastened engraved, laminated acrylic or melamine label for areas with adverse environments (outdoor, unconditioned, high humidity, detrimental vapors, etc.). Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
   b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   c. Select and install mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure. Secure to substrate with stainless steel fasteners on main switchboards and switchgear and in locations where adhesives cannot be expected to work long-term due to environmental conditions

2. Equipment to Be Labeled: (Project may not include all pieces of equipment.)

   a. Equipment Enclosures and Cabinets (including section, and including typewritten directory of circuits in the location provided by equipment manufacturer where applicable, and including clear description of upstream equipment and device from which the power originates).
   b. Access doors and panels for concealed electrical items.
   c. Monitoring and local/remote-controlling devices via engraved nameplates or wall plates as applicable.
   d. Other similar equipment designated by Owner's Representative or Design Professional in field.
   e. Service Entrances: Include name of engineering firm, name of installing contractor and year of installation at service-entrance equipment.

O. Fire Alarm Systems: Provide permanent identification for boxes, enclosures, etc. that are associated with fire alarm system work. Paint and identify fire alarm system pull boxes, junction boxes, and other access/pull points (boxes and covers) in accordance with NEC/NFPA. Provide fire alarm system control panel equipment cabinets, enclosures, etc. with engraved nameplates (white letters on red background) with the first line of text to read "FIRE ALARM" and the remaining lines to include the necessary descriptive text. Properly identify system components, wiring, cabling, and terminals. Install framed instructions in a location visible from fire-alarm control unit. Provide red color on jacket of all fire alarm cables associated with the fire alarm system. Provide red-colored breaker handle and red-colored lock-on device at source circuit breakers that feed fire alarm related equipment. Provide red coloring for all fire alarm system junction boxes, along with identification.

END OF SECTION 260553

SECTION 260584 - MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to documents of other divisions for further requirements associated with equipment and devices that are addressed in this section. This section includes supplemental information related to electrical work associated with mechanical equipment and other equipment furnished and/or installed under all other divisions or by others. Information included in this section applies not only to traditional mechanical equipment, but also to equipment of any kind that is furnished and/or installed by any supplier or installer.

PART 2 - PRODUCTS - REFER TO APPLICABLE SPECIFICATION SECTIONS

PART 3 - EXECUTION

3.1 GENERAL

A. Common Requirements:

1. Provide all necessary electrically related work as required to render all mechanical equipment (including plumbing, heating, ventilating and air conditioning equipment) fully operational and fully compliant with NEC. This includes, prior to ordering materials or commencing with rough-in, reviewing equipment submittal data and coordinating with installing contractors to ensure the correct size, rating and quantity of conductors are provided.
2. Refer to Coordination Schedules on drawings. Provide disconnects, controllers, starters, accessories, wiring, connections, services, etc. where defined as “EC” in the schedule. Information in this section supplements the information in the HECS.
3. Provide power wiring and connections for all equipment (including motor dampers, accessories, etc. as applicable) as required to render equipment fully operational.
4. Provide engraved plates at all local disconnects and/or controllers with equipment identification and mark indicated.
5. Install local disconnects and/or controllers at 48 inches to top of outlet box or enclosure as applicable above finished floor/slab/grade; provide flush mounted units in finished areas. Provide key operated controllers where accessible to general staff and/or general public.
6. Drawn locations of equipment and devices are shown only for schematic indication of wiring requirements. Coordinate with locations and rough-in requirements as required to determine actual locations and termination requirements. Refer to all contract documents for additional electrical requirements and concerns, and for further representation of this work.
7. Provide raceway, wiring, connections, and terminations for power and interlocks for electrically operated equipment. Provide disconnect switches and/or starters for mechanical equipment unless specifically indicated otherwise herein or on the drawings.
8. Provide disconnect switch ahead of all equipment, including controls, unless the mechanical equipment comes with integral NEC-compliant disconnect(s). Provide NEMA 3R enclosures where installed outdoors and where installed indoors in areas subject to moisture. Ground metal frames of equipment by connecting frames to the grounded metal raceway or to a full size green ground conductor or both. Provide the necessary

electrical connections between the specified equipment and the junction box near equipment with flexible metallic conduit (liquid-tight outdoors) and matched connectors (see Section 26 05 33). Where mechanical equipment lugs cannot accommodate conductor sizes shown on drawings, provide ILSCO ClearTap Insulated Multi-Tap Connectors.

9. Sizes, electrical ratings, etc. of equipment and wiring shown on drawings are based on the respective equipment design base manufacturers. If different manufacturer(s) or model(s) are actually supplied, provide necessary coordination in field (prior to ordering materials and prior to rough-in) and provide the necessary size of related electrical equipment, wiring, conduit, etc.
10. Prior to furnishing submittals and prior to rough-in, determine exact electrically related characteristics, loads, voltages, disconnects and/or starters, and accessory requirements, locations, mounting heights, connection points, etc. of mechanical equipment.
11. Provide lugs, lug kits and related accessory work as required to accommodate the conductor sizes and quantities needed for each application. Coordinate with single-line diagram, field conditions, equipment installers, etc.
12. Coordinate in field with the respective trades and determine case by case, which equipment is factory listed for use with Heating and Air Conditioning Rated (HACR) breakers. In an effort to minimize requirements for stocking of fuses by the Owner, utilize HACR breakers at the source panelboards as the NEC required overcurrent protection wherever possible (in lieu of fusing local disconnect switches).
13. Disconnect Switch and/or Starter Locations: Locations shown on drawings are indicated for schematic purposes only. Determine exact locations in field so that they are compliant with NEC Article 110.26.

B. Maintenance Receptacles for Equipment: Provide duplex receptacle within 25 feet of all electrically operated equipment of any nature that requires periodic testing or maintenance. Provide Type WR duplex GFCI weatherproof receptacle for outdoor applications (including rooftops) and for applications subject to high humidity or moisture.

C. Equipment and Systems:

1. HVAC Equipment with Multiple Integral Electrically-Operated Components: Provide separate power feeds or single power feed as directed in field by the HVAC installer (field verify prior to rough-in). Modify disconnect and/or starter requirements accordingly, if required. Provide additional dedicated 120V, 20A branch circuit for each unit from nearest panelboard (if not indicated clearly on the electrical drawings) for internal factory-installed lighting and receptacles. Provide conduit, wiring, and overcurrent protection for this work, and terminations to connections within the heat recovery units for this lighting and convenience power.
2. Split System Air Conditioning Systems: Provide (1) 3/4 inch empty conduit (with drag line) from each air handling segment to each condensing unit. Provide control conduit between pair to follow refrigerant piping routing wherever practical.
3. Cooling Towers and Condensers:

    a. Provide a weatherproof non-fused NEMA 3R local disconnect switch at the unit. Provide line voltage power wiring, and connections to the control panel. Provide (1) 1" empty conduit from the cooling tower control panel to indoor chiller or BAS/temperature control panel as applicable.
    b. Provide power wiring (ground fault protected per NEC) for basin heater and heat trace, and connect to related control panel. Wire and connect basin thermostat/aquastat to control panel and provide heat trace cable connections to control panel. Provide local weatherproof disconnect and related field wiring/connections. Provide Type XHHW-2, low-leakage, branch circuit

conductors. Keep branch circuit wire splices to an absolute minimum and properly insulated to prevent leakage. Provide Ground Fault Equipment Protection (GFEP) type circuit breakers at source panelboards for these branch circuits, per NEC Article 427, even if not shown as such on schedules. Provide enclosed NEMA 3R contactors as needed for complete operational systems.

4. Ductless Split System Air Conditioning Units:

   a. Provide power, control and interlock wiring and connections, to indoor and outdoor equipment.
   b. Provide local weatherproof fused disconnect at each outdoor condensing unit.
   c. Provide power, control and interlock wiring in conduit from each outdoor condensing unit to respective indoor air conditioning unit. Determine specific wiring requirements in field from HVAC installer since these wiring specifics vary by manufacturer. Provide related wiring as required to render systems fully operational.
   d. Provide 2-pole local flush snap switch disconnect at each indoor air conditioning unit (with pilot light).
   e. Route control conduit/wiring between each air conditioning unit and respective condensing unit to follow refrigerant piping routing wherever practical.
   f. Provide power home-run from each outdoor condensing unit, or from each indoor air conditioning unit, or from both unit for each application. Determine specific wiring requirements in field from HVAC installer since these wiring specifics vary by manufacturer. Provide related power home-runs as required to render systems fully operational.

5. Control Wiring:

   a. General: Unless specifically indicated as empty conduit on drawings or herein, provide electrical control and interlock work as shown on drawings. Provide additional control work as specifically indicated herein. Coordinate HVAC thermostat and sensor locations in field (case by case) with Design Professionals, Owner’s Representative and equipment installer to ensure that they are placed in locations that will not interfere with furniture, equipment, artwork, wall-hung specialties, room finishes, etc. Field-verify these wall locations case by case, prior to rough-in, since locations shown on drawings are schematic only.
   b. Schematic Thermostat and Sensor Locations: Refer to HVAC drawings and documents to determine locations and quantities if locations are not shown on electrical drawings, and to confirm locations and quantities even if locations are shown on electrical drawings.
   c. Low Voltage Thermostats and Sensors: Provide 4-inch square by 2-1/8 inch deep wall outlet boxes at 46 inches above finished floor to center of outlet box (with single-gang rings) for each unit. Provide one 3/4-inch empty conduit from each location, turned out above accessible ceilings (in joist space or against overhead slab/deck). Identify conduit in ceiling cavity; provide sweep bends, bushings and drag line.
   d. Line Voltage Thermostats and Sensors: Provide 4-inch square by 2-1/8 inch deep wall outlet boxes at 46 inches above finished floor to center of outlet box (with single-gang rings) for each unit. Provide line voltage power wiring, in 3/4-inch conduit, and connections from thermostats and sensors to respective equipment that is to be controlled by same. Install thermostats and sensors.

6. Domestic Water Heaters (Gas): Provide electrical 120VAC power connection. Provide interlock wiring with circulating pumps, flow switches and aquastat controls as applicable. Refer to wiring diagrams on drawings for further definition where applicable.

7. Domestic Water Heaters (Electric): Provide local disconnect switch, and power wiring and connections. Provide interlock wiring with circulating pumps, flow switches and aquastat controls as applicable. Refer to wiring diagrams on drawings for further definition where applicable.
8. Domestic Hot Water Circulating Pumps (Return Line): Provide manual starter with pilot light, and wire pump to operate through the aquastat. Refer to wiring diagrams on drawings for further definition.
9. Electric Water Coolers (Surface): Provide l20V duplex receptacle. Provide GFCI circuit breaker to feed the circuit that serves electric water coolers, even if not indicated on panelboard schedule. Install at height and location as directed by water cooler installer. Conceal outlet within water cooler enclosure if enclosure is designed for such an installation. Assemble and connect cord if needed. Coordinate all specifics with water cooler installing contractor prior to rough-in of related work.
10. Electric Water Coolers (Flush): Provide l20V duplex receptacle or provide direct 120V connection with local switch (verify required method in field with electric water cooler installer). Provide GFCI circuit breaker to feed the circuit that serves electric water coolers, even if not indicated on panelboard schedule. Install outlets at height and location as directed by water cooler installer. Conceal outlets within water cooler enclosure if enclosure is designed for such an installation. Assemble and connect cord if applicable and needed. Coordinate all specifics with water cooler installing contractor prior to rough-in of related work.
11. Domestic Hot Water Circulating Pumps (Heater to Tank): Provide manual starter with pilot light, and wire pump to operate through the aquastat. Refer to wiring diagrams on drawings for further definition.

END OF SECTION 260584

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For equipment, materials and systems specified in this section. Include product data, descriptive information, technical data, wiring diagrams, load restrictions, etc.

A. Shop Drawings

1. Submit lighting control drawings with actual occupancy/ vacancy sensor quantities, types, locations and coverage patterns as needed to provide fully operational coverage for each affected area.

PART 2 - PRODUCTS

2.1 MANUAL LIGHTING CONTROL DEVICES – SEE SECTION 262726.00

2.2 OCCUPANCY SENSORS

A. General

1. Provide labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of completely operational occupancy sensor lighting controls, as described herein.
2. Provide products supplied from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years.
3. Provide occupancy sensors for entire project that are all made by the same manufacturer, regardless of where the materials are specified in Division 26 documents. Provide components that are all made by the same manufacturer in cases where occupancy sensor components are also connected to a building lighting control system, regardless of where the materials are specified in Division 26 documents.
4. Provide components that are U.L. listed, offer a five (5) year warranty and meet state and local applicable code requirements.
5. Provide products manufactured by an ISO 9002 certified manufacturing facility with a defect rate of less than one-third of one percent.
6. Provide sensors capable of operating normally with LED Drivers, electronic ballasts, PL lamp systems and rated motor loads.
7. Provide sensors with coverage that remains constant after sensitivity control has been set. Automatic reduction in coverage due to the cycling of air conditioner or heating fans is not permitted.
8. Provide sensors with readily accessible, user adjustable settings for time delay and sensitivity. Locate settings on the sensor (not the control unit) and recess to limit tampering.
9. Provide bypass manual override on each sensor to accommodate failures. Configure so that when bypass is utilized, lighting remains on constantly or control diverts to a wall switch until sensor is replaced. Recess this control to prevent tampering.

10. Provide sensors with an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
11. Where specified, provide sensor with internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Do not use sensors that utilize separate components or specially modified units to achieve this function.
12. Provide sensors with UL rated, 94V-0 plastic enclosures.

B. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.

1. Cooper Greengate CA
2. Hubbell
3. LC&D
4. Leviton
5. Lutron
6. Sensor Switch
7. Phillips
8. Wattstopper

C. Dual technology sensors: Provide sensors that are either wall mounted, corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas. Provide passive infrared and ultrasonic or microphonic technologies for occupancy detection.

D. Ceiling Sensors: Provide Standard of Quality equal to WattStopper: WT-605, WT-600, WT-1105, WT-1100, WT-2205, WT-2200, WT-2250, WT-2255, WP-605, WP-1105, WP-2255, WP-2205, W-500A, W-1000A, W-2000A, W-2000H, UT-300, UT-305, UT-355, WPIR, HB-100, HB-150, DT-200, DT-205, DT-300, DT-305, DT-355, CX-100, CX-105, CI-200, CI-205, CI-300, CI-305, CI-355, CI-12 or CI-24 series.

E. Power and Auxiliary Packs: Provide Standard of Quality equal to WattStopper: B120E-P, B277E-P, BZ-100, LC-100, C120E-P, C277E-P, S120/277-P, AT-120 or AT-277 series.

F. Circuit Control Hardware: For ease of mounting, installation and future service, provide control units that are able to be externally mounted through a 1/2" knock-out on a standard electrical enclosure and be integrated, self-contained units consisting internally of isolated load switching control relay and transformer to provide low-voltage power. Provide control units that provide power to a minimum of two (2) sensors. Provide control wiring between sensors and controls units that is Class II , 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums. Provide minimum #12 AWG wire gauge to and from the circuit control hardware relays. Provide Relay Contacts with ratings of:

1. 13A - 120 VAC Tungsten
2. 20A - 120 VAC Ballast and LED Driver

PART 3 - EXECUTION

3.1 GENERAL

A. Installation: Provide grounded (“neutral”) conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used.

B. Occupancy Sensors

1. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Provide ninety (90) to one hundred (100) percent coverage in rooms to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the rooms. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover the respective room.
2. Arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.
3. Exercise proper judgment in executing the installation to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
4. Provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing controls.
5. Upon completion of the installation, provide complete commissioning for controls by the manufacturer's factory authorized technician who will verify adjustments and sensor placement to ensure trouble-free occupancy-based lighting controls. Provide the Owner and Design Professionals with ten working days written notice of the scheduled commissioning date. Upon completion of related work, including fine tuning, provide factory authorized technician training to the Owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION 260923

SECTION 262113 - LOW-VOLTAGE OVERHEAD ELECTRICAL SERVICE ENTRANCE

PART 1 - GENERAL

1.1 ELECTRICAL POWER SERVICE

A. The electric service includes utility company transformer as indicated on drawings, furnished by local utility company, with secondary voltage as indicated on drawings.

B. Furnish and install all work in strict compliance with all requirements set forth by the utility company providing electrical service for the project. Procure all needed details and information directly from the utility company as required for complete operational installations. Furnish and install all electrical work accordingly. Such work includes, but is not limited to: Insulators, weatherheads, metering, supports, conduit, wiring, connections, maintaining clearances, testing, inspections and ancillary work as applicable.

C. Determine available fault current from electric utility company and provide appropriately rated electrical service and distribution equipment to accommodate not only the initial transformer proposed by the utility company, but also a future larger transformer if applicable to allow for full usage of the electrical service capacity.

D. Where indicated in project manual, or where indicated on drawings, or where required by NEC, install ground-fault protection devices complying with electrical winding polarities indicated. Set field-adjustable GFP devices and circuit breakers for pickup and time-current sensitivity ranges as indicated, after installation of devices and CB's.

E. Provide secondary conduit(s) and wiring from outdoor weatherhead to service disconnect(s). Coordinate insulator locations, weatherhead locations and conductor tail lengths with utility company prior to commencing with any related work. Provide meter base, associated conduit(s), and current transformer cabinet if required. Provide all work per utility company requirements and standards. Utility company will furnish and install the transformer and the overhead drop, and will make final overhead connections. Coordinate with drawings for number of spans, poles, special conditions, etc.

F. Remove bonding jumpers between neutral bars and equipment ground bars for applications where new electrical power services are being provided and are “back-feeding” previously existing electrical power service equipment. Provide insulated equipment ground conductors with all such “back-feeders”.

PART 2 - PRODUCTS: REFER TO APPLICABLE DIVISION 26 SECTIONS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with other electrical work, including utility company wiring, as necessary to interface installation of service entrance equipment work with other work. Provide service entrance

conduits with sweep L's. Properly seal conduits, immediately upon installation, to prevent water, moisture, dirt, rodents, insects, etc. from entering ducts.

B. Prior to commencing with any service entrance related work, carefully coordinate installation of service work with affected utility companies, with Owner's Representative, with other trades, with affected entities, and with authorities having jurisdiction.

C. Provide tight system and equipment grounding and bonding connections for service-entrance equipment, and wiring.

END OF SECTION 262113

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each provide bus configuration, current ratings, voltage ratings, SCCR Ratings, overcurrent protective device(s), surge suppression device(s), accessory, and components indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Industry, Inc.
4. Square D; a brand of Schneider Electric

B. Enclosures: Refer to electrical drawings and coordinate with field conditions for cabinet mounting types (i.e. flush, surface, flush and surface).

1. Rate for environmental conditions at installed location.
2. Hinged Front Cover: Entire front trim neatly bolted to box (or equivalent concealed clamping or similar method), and with standard door within trim cover. Provide dead front behind standard trim door, bolted in place, to cover bare wiring, lugs, bussing and terminal bars. Provide concealed hinges. Provide concealed hinges, secured with flush latch with tumbler lock and keyed alike.
3. Provide additional features where indicated on drawings or needed due to field or architectural conditions. Such features include, but are not limited to, the following.

    a. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
    b. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

4. Panel and Trim Finish: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
5. Back Box Finish: Galvanized steel
6. Directory Card: Provide neatly typewritten circuit directory card for each panelboard upon completion of installation work. Include the actual room names/numbers that are selected for interior signage/designation.

C. Incoming Mains Location: Provide incoming main locations (top or bottom, or top and bottom) based on means and methods and conduit/raceway layouts that are planned for installation.

D. Phase, Neutral, and Ground Buses: Refer to electrical drawings, single line diagram and schedules for additional information on requirements for buses, as applicable.

1. Material: Tin-plated copper or aluminum.
2. Grounded ("Neutral") Bus: Provide 100% rated bus with sufficient lugs to accommodate grounded conductors for all circuits and pole spaces.
3. Equipment Grounding Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box; minimum 50 percent rated. Bond to grounded ("neutral") bus for service entrance applications only.
4. Extra-Capacity Neutral Bus: Refer to single line diagram and schedules.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Where 200 percent rated bussing is called for on single line diagram; provide 200 percent rating of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL/ULSE labeled for use as service equipment for units with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Provide all mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Fault Current Ratings

1. Provide electrical distribution related equipment with appropriately braced bussing and properly rated breakers, fuses, etc. for the available fault currents.
2. In existing buildings where fault current values are not indicated on drawings, coordinate with existing "upstream" distribution equipment, and provide equipment AIC ratings that meet or exceed same.

I. Provide panelboard branches as scheduled on the drawings. Provide circuit breaker panelboard bus assemblies with distributed (sequence) type bussing throughout, so that any two adjacent single-pole breakers, or spaces, are replaceable by a two-pole internal common trip breaker, and so that any three adjacent single-pole breakers, or spaces, are replaceable by a three-pole internal common trip breaker. This applies for branch breakers sized 15-amp through 70-amp inclusive, without disturbing any other breaker.

J. Provide dead-front safety type panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and with arrangement shown. Provide with lug

connectors approved for use with copper or aluminum conductors. Provide lugs, lug kits and related accessory work as required to accommodate the conductor sizes and quantities needed for each application. Coordinate with single-line diagram, schedules, field conditions, etc.

K. Provide integral factory-installed power supply system(s) to prevent electronic-trip breakers from tripping under conditions where load current may at any time fall below operational thresholds. Provide factory-wired power supply system(s), powered from the respective panelboard with integral overcurrent protection, control power transformer(s), etc. as necessary for complete operational system(s) without requiring any external or field wiring.

2.2 PANELBOARDS

A. Provide Distribution Panel construction for panelboard applications where indicated on drawings or where otherwise required based on power distribution requirements. Provide Panelboard construction for branch panelboards.

B. Provide circuit breaker panelboards unless indicated otherwise on drawings.

1. Circuit Breaker Branch Overcurrent Protective Devices: Bolt-on type, replaceable without disturbing adjacent units.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breakers (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

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 250 A and larger.
2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip
   b. Long- and short-time pickup levels
   c. Long- and short-time time adjustments
   d. Ground-fault pickup level, time delay, and I2t response

3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Mounting: Designed to be mounted and operated in any physical position, and to be operated in a minimum ambient temperature of 40 degrees C.; with mechanical screw type removable connector lugs, AL/CU rated.
   e. Size: Full size, no "tandem" or "split" breakers.

f. Position: All load-side box lugs of each breaker in the same gutter.
g. Common Trip: Common trip for multi-pole breakers so overload on one pole will trip all poles simultaneously. Provide multi-pole breakers with common trip (or with handle-ties, only if needed because breakers are existing) for applications where it is determined that a common disconnecting means is required for multi-wire branch circuits serving, or within, the same enclosure, outlet box, equipment, or device.
h. SWD Type: Provide for 15 and 20 ampere branch circuit breakers (UL Listed).
i. HACR Type: Provide for 15 through 70 ampere branch circuit breakers.
j. Spares: Place all spare circuit breakers in the 'OFF' position, provide with breaker locks, and schedule them as "Spare" on directory card.

2.4 ACCESSORIES

A. Provide panelboard accessories and devices including, but not necessarily limited to, overcurrent protection devices, ground-fault protection, etc., as recommended by panelboard manufacturer for ratings and applications indicated. Provide distribution equipment with ground bus bars. Provide a minimum of 20 handle, lock-on devices of the non-padlocking type for life safety, special systems and other essential circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount top of trim 90 inches above finished floor unless top-most breaker handle would end up being above 79 inches in which case the top of trim shall be mounted so that the top-most breaker handle will be below 79 inches. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable, circuit-breaker trip ranges and other applicable settings. Arrange conductors in gutters into groups. Install filler plates in unused spaces.

B. Provide neatly computer-typed/printed circuit directory card for each panel upon completion of installation work. Include the actual room names/numbers that are selected for interior signage and/or designation. Scheduling shown on drawings is shown to indicate feeder and branch circuiting requirements. Determine exact numbering sequence of circuits in field after performing final balancing.

C. Provide electronic circuit breakers where indicated on drawings or where required based on results of selective coordination study. Elsewhere electronic or thermal magnetic circuit breakers may be used, selected as required to accommodate project requirements.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type include electrical characteristics, configurations, ratings, markings, colors, etc.

1.2 GENERAL

A. Information regarding the following is included in other Division 26 specification sections and/or on drawings: weatherproof cover plates, special identification requirements, and occupancy sensors.

B. Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Verify color selections with Owner's Representative.

C. Coordination: Receptacles for Owner-Furnished Equipment: Match plug configurations. Cord and Plug Sets: Match equipment requirements.

D. Definitions:

1. EMI: Electromagnetic interference.
2. GFCI: Ground-fault circuit interrupter.
3. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
4. RFI: Radio-frequency interference.
5. SPD: Surge protection device.
6. Tamper-resistant: This term and “safety type” shall be taken to mean the same thing for receptacles.

PART 2 - PRODUCTS

2.1 GENERAL

A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below.

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper)
2. FSR Inc. (FSR)
3. Hubbell Incorporated (Hubbell)
4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
5. Hubbell Incorporated; Wiring Device-Bryant (Hubbell)
6. Legrand
7. Leviton Mfg. Company Inc. (Leviton)

8. Lutron Electronics, Inc. (Lutron)
9. Pass & Seymour/Legrand (Pass & Seymour)
10. Wiremold/Legrand (Wiremold)

B. For receptacle circuits protected with 15A breakers, provide NEMA 5-15R equivalents for the devices specified in this section.

C. Provide equivalent quality devices by manufacturers listed in subparagraphs hereafter for cases where voltage, amperage and/or NEMA configurations that are indicated on drawings or, are otherwise required based on project conditions, differ from those specified herein.

D. Provide Weather-Resistant Receptacles with UL “WR” marking, compliant with NEC 406.8, for all applications in wet or damp locations.

E. Where GFI protected receptacles are shown on drawings, provide a separate GFI receptacle for each one shown. Do not feed downstream receptacles from load-side (GFI-protected) terminals of upstream receptacles.

F. Provide corrosion-resistant versions of receptacles specified below for industrial applications and applications in corrosive or potentially-corrosive environments.

G. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions: Connectors shall comply with UL 2459 and shall be made with stranding building wire; connectors are NRTL listed for intended use; connectors comply with the requirements in this Section; connectors are permitted by Authorities Having Jurisdiction.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R (20A) or 5-15R (15A), UL 498, and FS W-C-596. Provide duplex and single specification grade receptacles, 2-pole, 3-wire grounding, self-grounding, green grounding screw, ground terminals and poles internally connected to mounting yoke, color coded base, 20-amperes, 125-volts, with metal plaster ears, back & side wiring, NEMA configuration 5-20R. Subject to compliance with requirements, provide one of the following (catalog numbers in subparagraphs below are for 20-A, heavy-duty, specification-grade, nylon-face devices; revise catalog numbers to require other configurations and ratings):

1. Cooper; 5351 (single), CR5362 (duplex)
2. Hubbell; HBL5351 (single), HBL5352 (duplex)
3. Bryant; 5351 (single), 5352A (duplex)
4. Leviton; 5351 (single), 5362 (duplex)
5. Pass & Seymour; 5351 (single), 5362 (duplex)

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide one of the following:

1. Cooper; TR8300
2. Hubbell; HBL8300
3. Bryant; 8300IL

4. Leviton; 5262
5. Pass & Seymour; TR63

C. GFCI Receptacles, 125V, 20A: Straight blade, feed-through or non-feed-through type depending on application. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Subject to compliance with requirements, provide one of the following:

1. Cooper; VGF20
2. Hubbell; GF20#LA
3. Bryant; GF20#LA
4. Pass & Seymour; 2097
5. Leviton; 6490

D. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A: Catalog numbers in list below are for feed-through types, arranged to protect receptacles downstream on the same circuit; revise catalog numbers if non-feed-through types are required. Subject to compliance with requirements, provide one of the following:

1. Hubbell; GFTR20
2. Bryant; GFTR20
3. Leviton; T7899
4. Pass & Seymour; 2097TR

2.3 TOGGLE SWITCHES

A. General: Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A: Subject to compliance with requirements, provide one of the following:

1. Single Pole:

   a. Cooper; AH1221.
   b. Hubbell; HBL1221.
   c. Bryant; 1121.
   d. Leviton; 1221-2.
   e. Pass & Seymour; CSB20AC1.

2. Two Pole:

   a. Cooper; AH1222.
   b. Hubbell; HBL1222.
   c. Bryant; 4902.
   d. Leviton; 1222-2.
   e. Pass & Seymour; CSB20AC2.

3. Three Way:

   a. Cooper; AH1223.
   b. Hubbell; HBL1223.

c. Bryant; 4903.
d. Leviton; 1223-2.
e. Pass & Seymour; CSB20AC3.

4. Four Way

a. Cooper; AH1224.
b. Hubbell; HBL1224.
c. Bryant; 4804.
d. Leviton; 1224-2.
e. Pass & Seymour; CSB20AC4.

2.4 WALL PLATES

A. Single and combination types shall match corresponding wiring devices. Provide metal plate-securing screws with head color to match plate finish. Provide factory markings on faces of receptacles that are controlled for energy management or building automation that are compliant with Article 406.3(E), including symbol and the word “Controlled”. Provide engraved wall plates where required by prevailing codes, indicated on drawings or indicated in Division 26 specifications.

1. Material for Finished Spaces: satin finish stainless steel, equal to Leviton Type 430 series
2. Material for Unfinished Spaces with surface-mounted outlet boxes: Galvanized steel
3. Material for Indoor Damp Locations: Gasketed satin finish stainless steel, equal to Leviton Type 430 series, with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant. Refer to Section 26 05 33.00.

2.5 FINISHES AND INDICATORS

A. Device Color (unless otherwise indicated or required by NFPA 70 or device listing):

1. General Wiring Devices: Ivory.

B. Wall Plate Color: For plastic covers, match device color.

C. Illuminated Indication: Provide illuminated face or indicator light versions of wiring devices specified herein where indicated as such on drawings and/or where required by prevailing code(s), to indicate that there is power to the device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordination with Other Trades: Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by

riding against outside of boxes. 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. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall. Install wiring devices after all wall preparation, including painting, is complete.

B. Conductors: Provide grounded ("neutral") conductor in all lighting control device (switch, dimmer, occupancy sensor, etc.) wall outlet boxes, even if not immediately used. Do not strip insulation from conductors until right before they are spliced or terminated on devices. 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. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails. Existing Conductors: Cut back and pigtail, or replace all damaged conductors; Straighten conductors that remain and remove corrosion and foreign matter; Pigtailing existing conductors is permitted, provided the outlet box is large enough.

C. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
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 the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Install wiring devices only in electrical boxes that are clean; free from building materials, dirt, and debris. Install wiring devices after wiring work is completed. Install wall plates only after respective wall surfaces have received their final finish.
11. Consider locations indicated on the drawings to be approximate (unless specifically dimensioned on drawings, or unless spacings must comply with prevailing codes). Study the general construction with relation to spaces and equipment surrounding each outlet.
12. Do not use aluminum products in concrete.
13. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Support boxes independent of conduit.
14. Provide feed-through-type GFCI receptacles where downstream receptacles are fed from the line side of the GFCI receptacle.
15. Adjust locations of outlets, devices, etc. to suit arrangement of partitions and furnishings.
16. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates
17. Receptacle Orientation: Install receptacles so that the ground pin is oriented in a consistent manner throughout the facility, so that the orientation is compliant with all prevailing codes and regulations, and so that the orientation is acceptable to the electrical inspector. Where there is no existing building standard or other project requirement,

install receptacles with ground pin down. Where receptacles are installed horizontally, install so that neutral connection faces up. Coordinate with AHJ and Owner.

18. Device 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.

3.2 TAMPER-RESISTANT RECEPTACLES

A. Provide tamper-resistant receptacles in compliance with NEC Article 406.12 for all applications. Install in all publicly-accessible spaces. Also install in the following spaces:

1. Child care facilities.

3.3 FIELD QUALITY CONTROL

A. Tests for Receptacles:

1. Line Voltage (120V): Acceptable range is 105 to 132 V.
2. Test for correct polarity and grounding.
3. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
4. Ground Impedance: Values of up to 2 ohms are acceptable.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
6. Using the test plug, verify that the device and its outlet box are securely mounted.
7. 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.

B. Installed equipment will be considered defective if it does not pass tests and inspections. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262726

SECTION 262816.16 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes. Include current ratings, voltage ratings, short circuit current ratings, accessories, features, etc.

PART 2 - PRODUCTS

2.1 SWITCHES

A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below. If not listed, submit as substitution.

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Industry, Inc.
4. Square D; a brand of Schneider Electric.

B. Characteristics:

1. 50 through 60 Hz., with 200,000 RMS symmetrical interrupting current rating.
2. 250VAC rated, for projects with service-entrance line to line voltage not exceeding 240V.
3. 600VAC rated, for projects with service-entrance line to line voltage not exceeding 600V.

C. Type HD, Heavy Duty: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate required fuses where applicable, lockable handle with capability to accept three padlocks, interlocked with cover in closed position, single or double throw as indicated on drawings.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location. Refer to drawings for NEMA type. Provide the following enclosure types if not noted on drawings, or if not noted otherwise on drawings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Commercial Kitchen Areas: NEMA 250, Type 4X, Stainless Steel.
4. Wash-Down Areas: NEMA 250, Type 4X, Stainless Steel.
5. Other Wet or Damp, Indoor Locations: Type 3R.
6. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install individual wall-mounted units with tops at uniform height unless otherwise indicated, or unless units must be stacked vertically, or unless field conditions otherwise dictate.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

E. Install disconnect switches within sight of controller position unless otherwise indicated.

F. Size units according to load being served or as noted on drawings, whichever requirement is larger. Provide units with horsepower ratings suitable to the loads where applicable. Install fuses and accessories as necessary to fulfill requirements of each application as applicable.

G. Subsequent to completion of installation of equipment, energize circuits and demonstrate capability and compliance with requirements. Begin by demonstrating switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure and inspect interiors, inspect mechanical and electrical connections, inspect fuse installations, and verify accuracy of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

H. Provide fuses of types specified in Section 262813.00, and of ratings as indicated on drawings.

END OF SECTION 262816.16

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type include detailed product information, light source, color temperature, color rendering index, lumen outputs, life, driver manufacturer, model and type, ceiling connection details, integral controls as applicable, drawings of custom fixtures or components, wiring diagrams, warranty, etc. Arrange luminaire submittals in booklet form with separate sheets for each luminaire, assembled by luminaire "type" in alphabetical order.

1.2 GENERAL

A. Provide all labor, materials, equipment, equipment, programming, services, etc. as required for complete and fully operational lighting and lighting control systems.

B. Definitions:

1. BF: Ballast factor.
2. CCT: Correlated color temperature.
3. CRI: Color-rendering index.
4. LER: Luminaire efficacy rating.
5. Lumen: Measured output of lighting source, luminaire, or both.
6. Luminaire: Complete lighting unit consisting of lighting source or sources, and some or all of the following components: optical control devices, contacts, mechanical components to support or attach the luminaire, and electrical and electronic components to start, operate, dim or control and maintain the operation of lighting source, and driving and transformation components.
7. Lighting Source: LED boards or equivalent LED assembly or, lamp (‘bulb”) for insertion into compatible socket, etc.
8. THD: Total harmonic distortion

1.3 QUALITY ASSURANCE

A. Obtain equipment and components from single manufacturer for luminaires of the same type and “family” style. Drawings indicate dimensions for typical equipment configurations including clearances between equipment and adjacent surfaces and other items. Ensure product complies with the layouts indicated in the drawings. Provide Components, Devices, and Accessories that are listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for all Emergency Lighting Batteries: five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Products: Subject to compliance with requirements, provide products indicated on Drawings. Provide products of one of the manufacturers listed in this section for products that are not defined on the Luminaire Schedule. Provide specification grade luminaires that comply with minimum requirements as stated therein. If a particular “type” does not include basis of design manufacturer or model number, provide "pre-approved equivalent” manufacturer’s and model numbers compliant with, and equivalent to: quality, performance, dimensions, and aesthetics as the respective basis of design for Design Professional review no less than five business days prior to bid due date.

B. Luminaires designated by letters are defined as indicated on the Luminaire Schedule.

C. Provide luminaires, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy-efficient light sources, contacts, reflectors, wiring, etc.. Ship luminaires factory-assembled, with components required for a complete operating installation.

D. Recessed Luminaires:

1. Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.
2. Provide recessed luminaires with necessary gypsum board, plaster frames, and surface trim.
3. Provide recessed luminaires that are constructed without rolled edges and that are post-painted.
4. Provide door frames on troffer style luminaires with spring latches on door frames.
5. Provide static air function for luminaires unless otherwise noted.
6. Provide luminaires that are non-IC constructed unless otherwise noted.
7. Provide junction boxes and serviceable components (driving and transformation component types, thermal protection devices, fuses, etc.) for recessed luminaires that are accessible for service and replacement from below the ceiling, without removing ceiling components.
8. Where plaster frames are inferred for luminaires (either by narrative, or by catalog number, or by application) interpret the actual function to mean for mounting within gypsum board, wet plaster or similar type inaccessible ceiling system. Field verify related requirements and provide required accessories, such as frames, accordingly.
9. Provide UL approved (listed and labeled) thermal protection per latest edition of NFPA/NEC for recess mounted luminaires.

E. Surface Luminaires: Install surface mounted luminaires with air spaces between luminaire and surface per latest edition of NFPA/NEC. Provide factory luminaire wiring that is per NEC, #16 AWG minimum. Wire luminaires having medium base and mogul base sockets with not smaller than No. 16 or No. 14 wire respectively in accordance with the latest requirements of the National Electric Code.

F. Review drawings and specifications of other trades to verify ceiling types, modules, and suspension systems appropriate to installation.

G. Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5, 5A, 5B, etc. as applicable.

H. Metal Parts: Free of burrs and sharp corners and edges.

I. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

J. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit replacing lighting source(s) without use of tools. Design to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position. Fabricate luminaires with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen generated noise.

K. Diffusers and Globes: Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation, UV stabilized. Provide at least 0.125 inch minimum lens thickness unless otherwise indicated. Glass: Annealed crystal glass unless otherwise indicated.

L. Factory-Applied Labels: Comply with UL 1598. Include recommended lighting sources, and driving and transformation components. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lighting sources are in place.

1. Label shall include the following characteristics:

a. "USE ONLY" and include specific lamp type.

2.2 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with light source driver(s)/board(s). Install remote from luminaire if so indicated on drawings, at accessible location and wired as directed by manufacturer. Comply with UL 924.

1. Emergency Connection: Unless noted otherwise, operate light source continuously at full output. Connect unswitched circuit to battery-inverter unit and switched circuit, and/or control wiring as applicable, to luminaire ballast.
2. “Nightlight” Connection: Operate at full output continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
b. Indicator Light: Pilot LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red pilot LED.
7. Provide Bodine Cold-Pak series or approved equivalent. Provide emergency ballast with temperature-control circuitry to fulfill both low-temperature and high-temperature operation. Provide emergency ballast with high-temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry contained in one nominal 14” x 3” x 1-1/2” red metal case. Provide solid-state charging indicator light to monitor the charger and battery, a test switch, and installation hardware. Provide emergency ballast capable of operating luminaire at full light output in the emergency mode for a minimum of 90 minutes. Provide unit that is suitable for use in damp locations and suitable for use in sealed & gasketed luminaires. Provide unit with storage and operating temperature range for the B50Cold-Pak of -20 degrees C to +55 degrees C. Provide emergency ballast UL listed for installation inside, on top of, or remote from the luminaire. Provide unit with full five-year warranty from the date of purchase.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 LIGHT EMITTING DIODE (LED) SYSTEMS

A. Light Emitting Diode (LED) Systems

1. LED Sources: Provide factory installed LED modules that are specifically designed for, and matched and mated to, the respective luminaire in which they are used. Provide LED modules that can easily be replaced in the field and are readily accessible for replacement. Provide color temperature as indicated in Luminaire Schedule.

2. LED Drivers; Provide factory installed driver(s) for the LED source utilized that are specifically coordinated to the LED source and luminaire in which they are used. Provide driver(s) having specific operating characteristics defined in the Luminaire Schedule. Provide driver(s) that can easily be replaced in the field and are readily accessible for replacement. Provide specification sheet for the specific driver as part of the Luminaire Submittal.
3. Total Harmonic Distortion (THD) Rating: Less than 20 percent. Provide factory-installed integral filtering system to ensure THD does not exceed 20 percent regardless of quantities and/or mixes with other manufactured LED systems.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Support fixtures in compliance with NEC. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. For open ceiling spaces where fixtures are suspended and subject to damage or impact, provide an additional air craft cable support securely fastened to luminaire and structure to act as a safety chain providing a redundant support. Select cable based on manufacturer’s recommendations, accounting for weight of luminaire assembly, external forces that could be applied, minimum 200% factor of safety, etc. Decorative pendants in finished spaces are exempt from this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Luminaires: Set level, plumb, and square with ceilings and walls unless otherwise indicated. Install lighting sources in each luminaire.

B. Temporary Lighting: If it is deemed necessary, and permitted by Owner’s Representative and Design Professionals, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is substantially complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Driving and Transformation Components: Distance between the driving and transformation components and luminaire shall not exceed that recommended by the

luminaire and driving and transformation components manufacturer. Verify, with manufacturers, maximum distance between driving and transformation components and luminaire.

D. Lay-in Ceiling Luminaires Supports: Unless required otherwise under other sections or unless project requirements and conditions require otherwise, grid may be used as a support element, subject to coordinating installations with ceiling system installer to ensure the ceiling system installer accounts for the weights of each luminaire and of all luminaires collectively, and installs specially marked and designated ceiling support components.

1. Install ceiling support system rods or wires for each luminaire. Locate not more than 6 inches from luminaire corners.
2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

E. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Install surface and recessed ceiling luminaires on grid and tile ceilings to agree with module of ceiling either displacing a tile, or unit on center of tile, or centered on grid lines. Install flush mounted luminaires properly to eliminate light leakage between luminaire frame and finished surface.

G. Do not locate splice or tap within an arm, stem, or chain. Provide wiring continuous from splice in outlet box of the building wiring system to driving and transformation component terminals in luminaires.

H. Provide Type MC Cable or wiring in minimum 1/2” diameter flexible metal conduit (with full parity sized green insulated equipment ground wire) for "drops" from building wiring system junction boxes to suspended ceiling mounted luminaires. Limit the length of these “drops” to 72”. Install "drops" to luminaires in gypsum board, and similar inaccessible ceiling systems, from identified accessible junction boxes.

I. Connect luminaires utilized for emergency egress lighting and exit signage ahead of switching and other controls. The only exceptions to this are photocell-only controls for outdoor emergency egress luminaires.

J. Provide luminaires and luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Owner's Representative and review by ceiling installer. Anchor luminaires installed in, or on, suspended ceiling systems in strict compliance with NEC, including advance coordination with the ceiling installer. Support surface mounted luminaires greater than 2 feet in

length at a point in addition to the outlet box luminaire stud. Fasten electrical luminaires and brackets securely to structural supports. Install luminaires level and plumb.

K. Where special mounting conditions are encountered, such as mounting to rounded columns or similar special circumstances, provide special custom factory-fabricated mounting means (i.e., brackets designed to conform with curvature of rounded columns, or to conform with similar special surfaces).

L. Provide stems and chains for luminaires as designated by the Owner's Representative where deemed necessary by the Owner’s Representative to achieve a functional and neat installation. Contact Owner’s Representative to determine pendant, stem, and chain lengths if mounting height is not indicated.

M. Provide plaster frames, or gypsum board frames, or similar kits for recessed luminaires installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

N. Wear clean white cotton gloves when handling the luminaires reflective and diffusing surfaces. Clean surfaces including dust, finger prints, paint, etc. with a clean dry cheesecloth after interior work has been completed. Remove plastic shipping bags from luminaires only after work in the respective area is complete.

O. Where applicable, verify that measured illuminance values comply with respective isolux (or equivalent) plot diagram values.

P. Provide full assembly for luminaires that are shipped with any loose components, regardless of who furnishes the luminaires.

Q. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to emergency source and retransfer to normal.

R. Burn-in all light sources that require specific aging period to operate properly, prior to occupancy by Owner.

S. Make adjustments and perform settings/programming to lighting controls so that all luminaires are fully operational compliant with design requirements and to the satisfaction of the Owner and Design Professionals.

T. Train Owner's maintenance personnel to adjust, operate, clean, re-lamp and maintain equipment, devices, controls, instrumentation, and accessories.

END OF SECTION 265100

SECTION 266001 - ELECTRICAL COORDINATION OF OTHER DIVISION EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. Provide equipment electrical characteristic data for equipment specified under other divisions of this project for an electrical coordination review. Submit each type of equipment submittal as a separate submittal, for example: Pool Equipment, Kitchen Equipment, Gymnasium Equipment, Motorized Shades, etc. Each submittal should be label as 266001-PD-## where ## increments from 00 for each submittal.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 266001

SECTION 284621.25 - FIRE ALARM SYSTEM EXTENSION

PART 1 - GENERAL

1.1 SUBMITTAL REQUIREMENTS

A. Product Data

1. For each type of devices including catalog numbers, electrical characteristics, ratings, color, temperature limitations, etc.
2. Submit as separate submittal (PD) but at same time as Shop Drawings for this section.

B. Shop Drawings

1. Provide a complete set of floor plan drawings showing conduit sizes and number of conductors required to all components plus detailed wiring connections required at each type of device. Clearly show the intended location of all field devices and their connections to the system. Include battery calculations, voltage drop calculations, critical dimensions, ductwork sizes for sampling tubes and associated required dimensions, wiring diagrams, sequence of operation, cable sizes and types, etc.
2. Shop Drawings shall be prepared by persons with the following qualifications: Trained and certified by manufacturer in fire-alarm system design, and licensed and certified by authorities having jurisdiction.
3. Submit as separate submittal (SD) but at same time as Product Data for this section.

1.2 GENERAL REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section. Refer to Division 26 sections for requirements associated with all electrical work not specifically defined in this section, which shall be considered additional and concurrent scope of work that is associated with work of this section.

B. Apply for and pay all required permits and fees. Submit to AHJ and issue revisions to AHJ as required to keep AHJ documentation current. It shall be the responsibility of the Fire Alarm System Manufacturer to furnish submittals to the authority having jurisdiction for approval. This action shall be taken during the shop drawing procedure. The system must be approved by this authority and a copy submitted to the Engineer for review.

C. Provide all materials, labor and services to provide fully operational modifications to, and extensions of, existing facility fire alarm system(s). Provide minimum 25% spare capacity for each data loop, each alarm circuit and for each set of power supplies and batteries.

D. Qualifications of system designers, installers, programming personnel, inspection personnel, testing personnel and maintenance personnel shall be trained and certified by manufacturer for installation of units required for this Project, and shall be qualified in compliance with requirements of NFPA, including Chapter 10.5 of NFPA 72.

E. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated: Notify Owner's Representative no fewer than two days in advance of proposed interruption of fire-alarm service; Do not proceed with interruption of fire-alarm service without Owner's Representative's written permission.

F. Sequencing and Scheduling: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building. After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

PART 2 - PRODUCTS

2.1 FIRE ALARM EXTENSION

A. Connecting to Existing Equipment and System:

1. Verify that existing fire-alarm system is operational before making changes or connections.
2. Connect new equipment to existing control panel in existing part of the building.
3. Connect new equipment to existing monitoring equipment at the supervising station.
4. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing control/monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
5. Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
6. Initiating Device, Notification Appliance and Signaling Line Circuits: Class A or Class A and B (provide Class A for circuits that provide isolation module protection for zones).
7. Provide Initiating Device, Notification Appliance, and Signaling Line Circuits that are NFPA 72, Class B, to match existing system.

B. General Requirements:

1. Provide materials and labor as required to result in a fully operational extension and modification to the existing fire alarm system.
2. Where indicated on drawings, remove existing fire alarm devices in affected areas and protect during demolition and construction phases. Clean and reinstall these existing devices as indicated on drawings. Relocate devices as indicated on drawings and extend conduit and wiring as required. Modify and/or extend related existing wiring in conduit as required.
3. Fire alarm system devices (smoke detectors, pull stations, A/V alarm indicating devices, etc.) shall be of the same manufacturer as, compatible with, and UL Listed and labeled for use on, the existing building fire alarm system.
4. Provide auxiliary contacts if required for special applications. All strobe alarms shall be ADA compliant, minimum 75cd per ADA unless specifically indicated on drawings with lower candela rating.
5. Install wall-mounted devices at the following heights above finished floor:

    a. Fire Alarm Manual Pull Stations: 46" to top of operating handle.

b. Fire Alarm Visual & A/V Annunciators: 80” to bottom of outlet box.
c. Fire Alarm Door Holders: 84”.

6. All new wiring shall be installed in strict accordance with manufacturer's requirements and installed in minimum 3/4" EMT conduit.
7. Program detailed device and room descriptions so that any trouble, supervisory or alarm condition clearly annunciates floor level, room number, room name, device, and indication of normal, alarm, trouble and supervisory status at fire alarm control panel(s), at fire alarm annunciator panel(s) and at the supervising central station.
8. The installation shall include a complete system test of the equipment by the local representative of the system installed. This test shall be performed in the presence of representatives of the Owner, Engineer, and local fire department.
9. Provide all required modifications (cards, power supplies, hardware, firmware, software, etc.) to the existing Fire Alarm system as required to render the entire extension fully operable.
10. Provide ceiling mounted smoke detector located above each control/power units (all types, including those for associated systems), if not already existing, and above all remote annunciators.
11. Provide all required 120VAC power as required to energize all new fire alarm related components. This requirement applies whether or not such power work is shown on the drawings. Branch circuits serving fire alarm related equipment shall be dedicated to fire alarm related equipment only.
12. Provide documentation (hard-copy and digital) of fire alarm system documentation, and provide a single documentation cabinet at the main fire alarm control unit, all in compliance with NFPA 72, including Chapter 7.
13. Provide power-limited cables that have a temperature rating of at least 60 degrees C; provide additional marking for conductor size and temperature ratings for cables rated in excess of 60°C (140°F).
14. Provide isolation modules as required to isolate wire to wire shorts on a data loop to limit the number of other modules or detectors that are incapacitated by the short circuit fault and/or grounds. Isolation modules shall be part of the smoke detector base. The isolation modules shall permit the entire system to operate independently of the area disconnected by the isolation module due to wiring faults. Provide isolation modules and wiring configurations (using Class A, or Class A and B, pathways) for fault isolation so that any one fault will not cause any part of the system to go down other than the zone of the fault; provide zoning compliant with prevailing codes, including NFPA 72, with at least one zone per floor (more if areas are subdivided into multiple zones by fire and/or smoke barriers).
15. Provide monitor modules in quantities as required to interface all "non-intelligent" devices into the system. Application examples include fire alarm system remotes panels, remote power supplies, etc. as applicable. Refer to documents of all trades since some such devices may not be specifically shown on electrical drawings. Review fire suppression system submittals and installation drawings to determine exact quantities and locations for devices that require monitor modules, as project drawings may not include all devices that require monitoring; provide monitor modules, wiring, connections, programming, etc. accordingly.
16. Provide control modules for all auxiliary devices.

C. Magnetic Door Holders

1. Description: Provide units that are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated. Provide blocking in wall. Install door holders at uniform heights as recommended by fire alarm system

manufacturer's representative. Verify that proposed mounting heights are acceptable with Architect.

3. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
4. Rating: 120-V ac, fed from local normal-utility power.
5. Material and Finish: Match door hardware.
6. Devices and Wiring: Provide one door holder for each door leaf. Provide control module(s) as required to automatically close doors when signaled by the fire alarm control panel under a predesignated alarm condition. Provide one smoke detector (listed for release service if control module is not used) on each side of the respective door or door set. Do not install door-holder power wiring in the same conduit as fire alarm system wiring. Provide control module, or equivalent functionality at the smoke detector bases, for interface with the fire alarm system, which may or may not be specifically shown in plan-view but shall be provided nonetheless. Provide 120-V ac power from nearest normal-utility-powered receptacle circuit unless indicated otherwise on drawings.
7. Operation: Unless indicated otherwise on drawings or herein, configure and program the fire alarm system so that all held-open doors are released upon any alarm condition that activates building notification devices.

D. Duct Smoke Detectors

1. The intelligent addressable duct mounted smoke detectors shall be photoelectric smoke detector unit.
2. Provide sampling tube per NFPA, test station and all other required accessories.
3. Duct smoke detectors are typically shown schematically at the respective air handling unit on the plans, but shall actually be installed maximizing the distances between ductwork offsets, and installed ahead of the first branch duct take-off. Coordinate with HVAC Contractor and fire alarm manufacturer's representative in field. The duct smoke detectors shall be intelligent addressable photoelectric.
4. Detectors shall operate at air velocities of 300 to 4000 feet per minute.
5. Coordinate placement of duct detectors with the HVAC contractor.
6. The shut-down of the air handler shall be via control module, unless specifically forbidden by the AHJ, in which case provide auxiliary contact as required to shut down equipment and wire into the stop circuit of the associated air handler starter.
7. Install all duct smoke detectors in the return air duct/plenum of the respective air handling equipment, or in multiple locations of the return duct branches if necessary to meet the minimum straight distances that are required by manufacturer of smoke duct detectors. Refer to HVAC ductwork drawings, and to HVAC installer's coordination drawings, for configurations when determining actual locations and quantities of duct smoke detectors. Where more than one detector is already indicated associated with a particular piece of air handling equipment, there are special reasons for the additional detectors (i.e. split returns, return risers serving multiple floors, etc.); coordinate all locations for same with the HVAC installer.
8. In cases where multiple HVAC units serve a common space, provide interlocking functionality so that activation of any one duct smoke detector (or spot smoke detector where applicable) provides shutdown functions for all HVAC units that collectively serve the affected space.
9. In cases where plenum-return methods are utilized for HVAC return-air, provide smoke detector suspended in the air stream near the entrance to the return-air intake to the HVAC unit(s). Install using materials, means and methods pre-approved by authority or authorities having jurisdiction.
10. Provide keyed test/monitor station (with status/alarm/trouble indicating LED's) on the ceiling or wall (flush in finished areas) beneath the duct detector at discreet but readily visible location as determined in field unless specific location is shown on drawings. Provide engraved (or approved equivalent method) plate at each remote station to read:

"#### Duct Smoke Detector", where #### is the equipment identification used on drawings. Connect to fire alarm system.

11. If required by authority having jurisdiction, provide identified key-operated air handler reset station on the ceiling or wall (flush in finished areas) beneath the air handler at discreet but readily visible location as determined in field unless specific location is shown on drawings. Provide engraved (or approved equivalent method) plate at each reset station to read: "#### Reset Switch to reset #### after a duct smoke detection event has been cleared and the fire alarm system has been reset.", where #### is the equipment identification used on drawings. Coordinate with authority having jurisdiction for verification of, or required modification to, the language to be engraved. Connect to fire alarm system.
12. Provide all required power and control wiring so that upon detection of smoke, the following sequence of operations occurs where applicable.

    a. Report as alarm or supervisory signal to the fire alarm system and monitoring central station based on prevailing codes and direction from AHJ (verify in field with AHJ), and A/V alarm annunciates at the remote test station.
    b. The HVAC unit shuts down (including applicable dampers).
    c. Associated smoke dampers close (wired to automatically re-open on duct detector reset).

PART 3 - EXECUTION

3.1 EXECUTION

A. Refer to "PRODUCTS" sub-section above.

B. Properly identify system components, wiring, cabling, and terminals. Install framed instructions in a location visible from fire-alarm control unit. Provide red color on jacket of all fire alarm cables associated with the fire alarm system. Provide red-colored breaker handle and red-colored lock-on device at source circuit breakers that feed fire alarm related equipment. Provide red coloring for all fire alarm system junction boxes, along with system identification.

C. Provide ceiling mounted smoke detector located above each control/power unit (all types, including those for associated systems), and above all remote annunciators. Provide weatherproof audible alarm notification device on the exterior wall at the location where the fire suppression sprinkler system water service enters the building.

3.2 PERFORMANCE

A. The following table shows the schematic sequence of operations for the Fire Alarm System.

FIRE ALARM SYSTEM SCHEMATIC SEQUENCE OF OPERATIONS											
Activate A/V annunciate of all event alarm/trouble signals at FACU and at remote annunciator(s) and transmit to History Log.											
Initiation Device	Event	Notify FACU and FARA	Activate A/V Alarm Devices	Notify Central Station	Shut Down Assoc. Eqt.	Shut Down Elev.	Activate Phase ½ Fireman Service	Activate Exh. Hood Fire Alarm Sequence	Activate Smoke Control/ Evac.Seq.	Activate Door Releases	Notes
Manual Pull Station	Alarm	X	X	X	X					X	9
	Trouble	X		X						X	

Ceiling Smoke/Heat Detector	Alarm	X	X	X	X					X	9
	Trouble	X		X							
Flame Detector	Alarm	X	X	X	X					X	9
	Trouble	X		X							
Sprinkler Flow Switch	Alarm	X	X	X	X				X	X	5,9
	Trouble	X		X							
Sprinkler Tamper Switch	Suprvs.	X		X							
	Trouble	X		X							
Low-Air Pressure of Dry Pipe Sprinkler System	Suprvs.	X		X							
	Trouble	X		X							
Elev. Mach. Rm. & Shaft Heat Detector	Alarm	X	X	X	X	X				X	2,9
	Trouble	X		X							
Elev. Mach. Rm., Shaft & Lobby Smoke Det.	Alarm	X	X	X	X		X			X	3,9
	Trouble	X		X							
Kitchen Exh. Hood Fire Protection Activation	Alarm	X	X	X	X			X		X	4,9
	Trouble	X		X							
Duct Smoke Detectors in Eqt. Serving Atrium	Alarm	X	See Note 1	X	X				X	X	1,5,9
	Trouble	X		X							
Duct Smoke Detectors	Alarm	X	See Note 1	X	X					X	1
	Trouble	X		X							
Smoke Detectors Assoc. with Other Mech. Eqt.	Alarm	X	See Note 1	X	X					X	1
	Trouble	X		X							
Smoke Detector Open to Atrium	Alarm	X	X	X	X				X	X	5,9
	Trouble	X		X							
Beam Smoke Detector(s) at Top of Atrium	Alarm	X	X	X	X				X	X	5,9
	Trouble	X		X							
Manual Controls for Smoke Control/ Evac.	Alarm								X		5
	Trouble										
Smoke Detectors at Smoke Dampers	Alarm	X	X	X	X					X	6,9
	Trouble	X		X							
Fire Pump	Alarm	X		X							10
	Trouble	X		X							10
Stage Heat Detectors	Alarm	X	X	X	X					X	7,9
	Trouble	X		X							
Carbon Monoxide (CO) Detectors	Alarm	X		V.I.F.							8
	Trouble	X		V.I.F.							

B. Sequence of Operation Notes:

1. Program to report as an alarm signal or as a supervisory signal, based on prevailing codes and direction from AHJ – verify with AHJ in field)

END OF SECTION 284621.25