# SECTION 23 0100 – BASIC MECHANICAL REQUIREMENTS

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions, (if any) and other General Requirements, apply to the work specified in this section.

B. Separation of Division 23 into Sections is for convenience only and is not intended to establish limits of work. Sections are as follows:

1. 230100 Basic Mechanical Requirements
2. 230500 Common Work Results for HVAC
3. 230517 Sleeves and Sleeve Seals for HVAC Piping
4. 230529 Hangers and Supports for HVAC Piping and Equipment
5. 230548 Vibration and Seismic Controls for HVAC Piping and Equipment
6. 230553 Identification for HVAC Piping and Equipment
7. 230593 Testing, Adjusting, and Balancing for HVAC
8. 232300 Refrigerant Piping
9. 233113 Metal Ducts
10. 233300 Air Duct Accessories
11. 233423 HVAC Power Ventilators
12. 233713 Diffusers, Registers, and Grilles
13. 238128 Ductless Split-System Air-Conditioners

### 1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations and expands the requirements specified in Division 1. These requirements are: Contractor's Qualifications, Quality Assurance, Reference Codes and Standards, Permits and Inspections, Equipment and Materials, Examination of Premises, Submittals, Coordination Drawings, Record Documents, Project Closeout, Warranty, Measurements, Operation Prior to Substantial Completion, Contractor Operation Prior to Substantial Completion, Electrical Work, Painting, Protection of Equipment and Work, Rough-ins, Mechanical Installations, and Cutting and Patching.

### 1.3 DEFINITIONS

A. The following definitions apply to all Division 23 specification sections:

1. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
2. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
3. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

4. Installer: The term "Installer" is defined as the entity (person or firm) engaged by the Contractor or its subcontractor or sub-subcontractor for performance of a particular unit of work at the project site, including installation, erection, application and similar required operations. Installers shall be skilled in the work they are to perform.
5. Specialist: The term "Specialist" means an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, and which maintains a regular force of workmen skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the contract. Where the contract specification requires installation by a specialist, that term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer's direct supervision.
6. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
7. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
8. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
9. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
10. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE

A. The following requirements apply to the work necessary to provide air conditioning system or systems, as specified in the various sections of this Division.

1.5 CONTRACTOR'S QUALIFICATIONS

A. An acceptable contractor for the work under this Division shall be a specialist in this field and have the personal experience, training and skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than 3 systems of comparable size and type to this one, that have served their owners satisfactorily for not less than 3 years. The foreman for this work shall have had experience in installing not less than 3 such systems and shall be approved before work is begun.

1.6 QUALITY ASSURANCE

A. Manufacturers:
   1. Trade names, manufacturers and catalog numbers are mentioned herein and on the Drawings solely in order to establish a standard for the type, general design and quality of product required. Other products similar in design, of equal quality and complying with the Drawings and Specifications will be considered after the contract is let only for those items with which the expression "or approved equal" is used. Where two or more manufacturers or materials are named, the Contractor may submit any of those named, provided they conform to the Specification. Identification in the project documents of any product by name, manufacturer or model number does not include either expressed or implied warranty of unqualified

product acceptance. All products must be capable of proper installation in the spaces provided, readily maintained and must satisfy other requirements contained in the contract documents.

2. If manufacturer and/or model number is indicated in the Contract Documents, it is for the purpose of identifying the product that is the “Basis of Design”. This means the product has been used as the basis for coordination for all architectural, structural, electrical, & mechanical requirements. If a manufacturer and/or model number other than the one named is procured, the Contractor shall be responsible for all changes necessary including additional design services incurred by the Owner to allow the installation of the selected product. It shall be the Owner's sole discretion to determine if additional design assistance is needed. Owner shall be compensated by the Contractor for the cost of the additional service to the Architect and/or Engineer to change the design and/or review the equipment placement changes elected to be made by the Contractor.

## 1.7 REFERENCE CODES AND STANDARDS

A. Requirements set forth in reference codes and standards are minimum for equipment, material and work. In instances where capacities, size, etc., of equipment, devices or materials listed in the Contract Documents exceed these minimums, listed or shown capacities, etc. shall prevail.

B. Comply with applicable laws, ordinances, codes and rules, with latest revisions adopted, of the following governing codes and agencies:

1. International Mechanical Code
2. Building Code of the City of Upper Sandusky
3. Fire Marshal of the State of Ohio
4. Ohio Plumbing Code, 2007 Edition
5. International Energy Conservation Code 2006

C. Industry standards and specifications issued by the following organizations shall apply to materials and workmanship:

1. AMCA Air Moving and Conditioning Association
2. ASME American Society of Mechanical Engineers
3. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
4. ETL Engineering Testing Laboratory
5. NEMA National Electrical Manufacturers' Association
6. NFPA National Fire Protection Association
7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association
8. UL Underwriters' Laboratories, Inc.

D. Local laws and codes take precedence over state laws and codes, which, in turn, take precedence over national codes and industry standards.

E. Comply with the rules and regulations of the "Safety Code for Mechanical Refrigeration", (ANSI/ASHRAE 15-2007). Meet the requirements of the ASME Unfired Pressure Vessel Code. All pressure vessels shall be stamped "ASME" and "National Board". Furnish to the Owner for each pressure vessel supplied under this Specification, a manufacturer's data report for unfired pressure vessels, Form U-I, as required by the ASME Code Rules.

F. This form must be signed by a qualified inspector holding a National Board Commission, certifying that construction conforms to the latest ASME Code for Unfired Pressure Vessels. The ASME symbol "U" also shall be stamped on each vessel.

1.8 PERMITS AND INSPECTIONS

A. Permits and Fees: Obtain and pay for all permits. Pay fees and all other payments required by utility regulatory bodies in connection with the Work. Pay for all inspections required under local codes with regard to the Work.

B. Certificates of Inspection: Upon completion of the work, furnish certificates of inspection from all inspection or regulatory agencies having jurisdiction over work of Division 23.

1.9 EQUIPMENT AND MATERIALS

A. Each item of equipment shall bear a name plate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. The plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.

B. The label of the approving agency, such as UL, AGA, ASME, ARI, AMCA, by which a standard has been established for the particular item, shall be in full view.

C. The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be the manufacturer's latest design.

D. Deliver equipment and materials to the site and store in original containers, suitably sheltered from physical damage and the elements, but readily accessible for inspection. Equipment damaged in shipment will not be acceptable.

1.10 EXAMINATION OF PREMISES

A. Visit the site of the proposed work before bidding. Inspect the site and become familiar with the difficulties and restrictions attending the execution of the contract.

B. No additional compensation will be allowed for failure to be informed of site conditions.

1.11 SUBMITTALS:

A. General:

1. Submit for review shop drawings, product data and samples. Comply with requirements of Division 1 Section "Submittals". Minimum number of copies shall be four (4). Mark each individual item with pertinent specification section and paragraph number. Submittal will be rejected if specification and paragraph number under which it is being submitted is not identified.

2. If the submittal deviates from the requirements of the Contract Documents, the deviation shall be identified in writing on the first page of the submittal. Identify where within the Contract Documents the deviation occurs. The deviation shall only be considered acceptable

if the identified deviation has been initialed by the Engineer. Any deviation not initialed may be assumed to be rejected. All coordination required due to the deviation, such as space allocation, changes to electrical service, or any other required changes shall be born as Work of Division 23 but accomplished by Installers skilled in the Work being performed. No costs incurred by the approved deviation shall be born by the Owner.

3. Review of shop drawings and submittals does not relieve the Contractor of responsibility for compliance with the specific requirements of the Contract Documents, or for fitting the equipment in the space allotted, with proper space for connection of piping or ductwork and for servicing or for coordination of the work with work of other trades. Approval of deviations also does not relieve the Contractor of responsibility for compliance with all other aspects of the Contract Documents.

4. Review is for general conformance with the design concept of the project and general compliance with the information given in the project documents. Responsibility for confirming and correlating all quantities and dimensions, selecting fabrication processes and establishing techniques of construction resides with Contractor. Review subcontractors' submittals and shop drawings and indicate by rubber stamp or letter that they have been reviewed and approved before forwarding them. Submittals and Drawings will be returned after review indicating whether or not exceptions are taken and the required procedure to be followed thereafter. Revised and acceptable submittals and shop drawings are required before construction is begun. Include dimensional data and weights of equipment. Include motor manufacturers' names.

5. In general, the Architect and/or his consultants will review each submittal as indicated above. If submittal does not comply with the Contract Documents as indicated by the submittal being marked "REJECTED" and "RESUBMIT", be responsible to the Owner for any additional costs the Owner incurs due to review of follow-on submittals.

B. Samples:

1. Submission of samples may be required by the Architect, particularly where equipment is visible in finished areas. Arrange demonstrations of a product's ability to perform as specified if required. Include dimensional data and weights of equipment. Include motor manufacturers' names.

C. Shop Drawings:

1. Shop drawings shall consist of plans, sections, elevations and details to scale (no smaller than 1/4" per foot), with dimensions clearly showing the installation. Direct copies of small scale project drawings issued to the Contractor are not acceptable. Drawings shall take into account equipment furnished under other Divisions and shall show space allotted for it. Include construction details and materials. As a minimum, submit shop drawings covering equipment rooms, equipment foundations, equipment supports, ductwork, field-fabricated equipment, piping or any other drawings specifically called for in this and other Sections. Include the following:

a. Controls and instrumentation, including complete electrical interlock.
b. Built-up equipment.
c. Equipment rooms (any room in which there is Division 23 equipment)
d. Equipment housekeeping pads, and vibration isolation.

e. Field-fabricated hangers, supports, guides and anchors.
f. Piping & Ductwork Layouts.

D. The drawings show existing construction components and systems as on record by the Owner. As part of the shop drawing process, field verifies location and size of structural members, location of partitions, and existing systems shown. If field measurements differ from the information on the drawings which causes a conflict in the Work, promptly consult the Architect for resolution. The Owner shall not be responsible for any delays in construction due to the Contractor failing to field verify information shown on the drawings as existing.

E. Product Data:

1. Submit product data within 45 days after award of the Contract and before any equipment or materials are purchased. Product data is defined as manufacturers' printed literature specifically marked to indicate size and model and accompanied by rating sheets listing values showing that equipment meets scheduled or specified values. Properly coded stamp "No exception taken" on submittal is required before ordering equipment unless otherwise noted.

2. Submit items identified in the individual Sections. If product data have not been received within 45 days after award of the Contract, only the manufacturer named shall be allowed e.g. if "American Standard or approved equal" is stated in the Contract Documents, after 45 days only the American Standard product shall be allowed, or if the scheduled equipment on the drawings indicates "Loren-Cook" for fans, after 45 days only Loren-Cook products shall be allowed.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 Section "Project Coordination" and as follows. Drawings shall be to a minimum scale of 1/4" = 1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other building systems, installations, and components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work.

B. Indicate the proposed locations of piping, ductwork, equipment, and materials and include vertical measurement from floor to bottom of piping, ductwork, and elevated equipment. Piping drawings shall include access panel locations, valves, sleeves, location of supports, etc. Ductwork drawings shall include access panel locations (in duct and building construction to obtain entry to service and maintain duct mounted equipment), vanes, scoops, splitters, dampers, grilles, diffusers, coils, etc. Vertical measurement shall be indicated at all changes in direction of piping and ductwork. Measurement shall be made to the outside surface of exterior insulated ducting and piping. Measurements shall include clearances for installing and maintaining insulation; servicing and maintaining equipment; space for equipment disassembly for periodic maintenance; and showing areas for tube, filter, and coil removal. Provide details of connections and supports, exterior wall and foundation penetrations, sizes and locations of concrete housekeeping pads, and indicate space for valve stem movement. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Include location of sleeves in floors,

walls, and ceilings. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication system components, sprinklers, smoke detectors, and other ceiling mounted items.

D. Provide digital copies of final coordination drawings, separated by trade, to the owner in dwg and/or pdf file formats.

E. Mechanical ductwork priority over all other systems being installed (MEP) above ceiling. Rerouting of installed systems due to uncoordinated drawings is the responsibility of the general contractor.

1.13 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout". As a minimum, record documents shall show ductwork; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair; piping systems with valves and control devices located and numbered according to tags; concealed unions and items requiring maintenance such as traps, strainers, expansion compensators, expansion and compression tanks. Locate all access panels installed to maintain mechanical equipment. Reference prominent building lines when showing dimensions of equipment, pipe, ducting, and access panels. Identify installations different from the original plans due to product substitutions, Contract Modifications, and actual equipment and material installed. All elements underground shall be shown giving actual inverts and horizontal locations. Engage the services of a Land Surveyor or Professional Engineer registered in the State in which the project is located to record locations and invert elevations of underground installations. Complete this survey work prior to the covering of the underground installation.

B. Provide digital copies of final record documents, separated by trade, to the owner in dwg and/or pdf file formats.

1.14 PROJECT CLOSEOUT

A. Mark and otherwise correct a set of reproducible drawings to reflect the final location of all work installed under Division 23, to serve as record documents, in accordance with Division 1 Section "Project Closeout". Locate cleanouts, valves, traps, manual and automatic dampers, fire and smoke dampers, control sensing elements in ducts, and other concealed items requiring adjustment or maintenance. Supplement with additional sketches on tracing paper for clarification, if necessary. Certify in writing that record drawings have been checked and are accurate. Submittal of these documents is a prerequisite for certification of substantial completion. Contractor may obtain a set of reproducible drawings from the Architect and shall pay for them.

B. Conform to other requirements included in Division 1 Section, "Project Closeout".

1.15 WARRANTY

A. Refer to applicable paragraph under GENERAL CONDITIONS. Warrant all materials and workmanship for a period of five years. Repair or replace promptly defects due to faulty materials, methods of installation or workmanship, with the least inconvenience and without expense to the Owner and at time designated by the Architect within the five-year period.

Additional specific performance or extended time warranties called for in the individual sections under this Division must be provided.

B. The warranty period for mechanical work shall commence on the date certified by the architect or engineer that the contract is substantially complete in accordance with the plans and specifications, or upon beneficial use by the Owner, whichever occurs first. When beneficial use is for only a portion of the work, the warranty shall commence only on that portion of the work.

1.16 MEASUREMENTS

A. Because of the small scale of the Drawings, it is not possible to indicate all offsets and fittings or to locate every accessory. Study carefully the sizes and locations of structural members, wall and partition locations, attic spaces, ceiling furring, chase spaces and room dimensions and take actual measurements on the job. Locate ductwork, piping, equipment and accessories, with sufficient space for installing, insulating and servicing. Contractor is responsible for accuracy of his measurements and shall not order materials or perform work without verification. No extra compensation will be allowed because field measurements vary from the dimensions on the Drawings. If field measurements show that equipment, piping or ductwork can not be fitted, the Architect shall be consulted. All equipment, apparatus and materials must fit into the available, designated spaces, with proper clearances for maintenance, service and repair.

1.17 OPERATION PRIOR TO SUBSTANTIAL COMPLETION

A. Owner shall have the right to operate systems and equipment prior to substantial completion, as soon as tested and operational, provided all safety devices have been installed. Agreement between Owner and Contractor relative to time and hours of operation and responsibility for start up and shutdown is required. Do not permit operation which may damage equipment or cause damage to the building or to the work of other contractors. Air filters must be in place on air conditioning units and strainers must be in place in all piping systems prior to operation.

1.18 CONTRACTOR OPERATION PRIOR TO SUBSTANTIAL COMPLETION

A. Obtain written authorization from the Owner for Contractor's use of equipment. If equipment is allowed to be used during construction period, all start-up requirements for the equipment shall be adhered to prior to operation including start-up procedures, required equipment check-out by factory authorized representatives, required equipment inspection reports, and commissioning as required in the individual Sections. A copy of operating and maintenance manuals shall be kept on-site while equipment is in operation. These manuals shall be made available to Owner's maintenance crews if Contractor is off-site and equipment is still in operation. In addition, no sooner than seven days prior to Substantial Completion being granted, original equipment check-out by factory authorized representative, required equipment inspection reports, and commissioning shall be completed a second time. Equipment or components found not in compliance with the Contract Documents shall be replaced without cost to the Owner. Submit by letter to the Owner the date in which each piece of equipment is put into operation.
B. Maintain duct cleanliness during air handling equipment use by installing minimum 30% filter material over all return and exhaust openings. If duct cleanliness is found by the Architect to be unacceptable, duct shall be cleaned with alcohol impregnated pad and pad changed as it loads with dirt. Provide additional access panels within the ductwork allowing cleaning to be completed. Added access panels required for this remedial cleaning shall be provided at no cost to the Owner.

1.19 ELECTRICAL WORK

A. General:

1. Electrical service shall be as indicated on the Drawings. All power wiring and all circuit breakers, starters, disconnect switches, pilot lights, hand-off-automatic (H-O-A) switches, pushbutton stations, except such items which are provided as part of "packaged" mechanical equipment or specifically noted herein, shall be furnished, set in operating position, and electrically connected as work of DIVISION 26, ELECTRICAL.

2. Should the Contractor desire to use equipment requiring larger motors or electrical characteristics differing from those shown, it is the responsibility of work requirements under Division 23 to inform other affected parties of the proposed changes to permit them to supply proper wiring, disconnects and starters. Additional costs incurred to work of other Divisions caused by such changes shall be borne as work of Division 23. Coordination to establish areas of possible change between Division 23 work and work of another Division shall occur prior to equipment delivery from the manufacturer.

B. Starters: Motor starters furnished with mechanical equipment covered by this section shall conform to the requirements of Division 26. Provide motor overload protection requirements for sizing overload protection device for motor starters furnished under Division 26.

C. Conduit and Wiring: As work of Division 23, all interlock conduit and wiring and control conduit and wiring shall be provided, and all control elements shall be set in position and connected. Electrical wiring for firestats or smoke detectors which interrupt line voltage power circuits to motors and for wall-mounted thermostats which interrupts line voltage power circuits to motors and interlock from smoke detectors for the shutdown of motors shall be work of Division 23. Provide control transformers and additional relays required for interface with the electrical system. Unless indicated otherwise, power wiring and conduit for all devices shall be work of Division 26.

1.20 PAINTING

A. Painting shall be done under Section 09900, except for touch-up of factory finishes on equipment located inside and outside. Obtain matched color coatings from the manufacturer and apply as directed. Prime coating of certain equipment is specified under individual equipment specification. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint in accordance with requirements of Section 09900.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 PROTECTION OF EQUIPMENT AND WORK

A. Continuously maintain adequate protection of stored materials and installed work. Tightly cover fixtures and equipment, with sheet polyethylene or waterproof tarpaulin as protection against dirt, rust and moisture. Provide heat to equipment being stored to prevent condensation. Do not store materials and equipment outside, directly on the ground, or in areas where it may be subject to physical injury from vehicular traffic or construction machinery. Ductwork, piping andequipment installed under this Division shall not be used by other trades as supports for scaffolds or

personnel. Do not deliver controls or other delicate equipment to the job site unless they can be placed in protected areas. At work completion, clean equipment, fixtures, exposed ductwork and piping, including hangers and supports to the Architect's satisfaction.

3.2 ROUGH-IN

A. Verify the final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Divisions 2 through 28 for rough-in requirements.

3.3 MECHANICAL INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment with other building components. Verify all dimensions by field measurements. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Sequence and coordinate installation of large pieces of equipment prior to closing in the building.

B. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

C. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect with a suggested resolution. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building components, where installed exposed. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components without requiring the removal of permanent construction or disabling the function of a required fire-resistance-rated assembly. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location external to the piece of equipment. Install access panel or doors where equipment is concealed behind finished surfaces. See Division 8 Section "Access Doors" and Division 23 Section for related basic mechanical materials and methods.

E. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope. In general, ductwork shall take precedence over piping. Set system elevations to minimize offsets where systems cross. Make full use of all three dimensions and stack ductwork, equipment, and accessories vertically as required. Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching". Engage experienced Installers in cutting and patching this work. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. See Division 1 Section "Definitions and Standards" for definition of "experienced Installer". Protect adjacent installations during all cutting and patching operations.

B. Perform cutting, fitting, and patching for mechanical equipment and material installation. Uncover work to provide for installation of ill-timed work. Remove and replace defective mechanical work and work not conforming to requirements of the Contract Documents. Install equipment and materials in existing structures. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

C. Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work covered prior to inspection. Uncovering and restoring work required to be observed by the Architect prior to covering as identified in the Contract Documents will be at no cost to the Owner.

D. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items as identified in the Contract Documents. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.

END OF SECTION 23 01 00

# SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

### 1.1 SECTION REQUIREMENTS

A. Summary: General requirements for motors, hangers and supports, vibration isolation, and meters and gages.

B. Submittals: Product Data for materials and equipment specified in this Section.

## PART 2 - PRODUCTS

### 2.1 MOTORS

A. Motor Characteristics (verify with other trades prior to ordering):

1. Motors 3/4 HP and Larger: Three phase.
2. Motors Smaller Than 3/4 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
8. Enclosure: Unless otherwise indicated, open dripproof.
9. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

### 2.2 HANGERS AND SUPPORTS

A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic coated for hangers in direct contact with copper tubing.

B. Building Attachments: Powder-actuated-type, drive-pin attachments with pullout and shear capacities appropriate for supported loads and building materials.

C. Mechanical-Expansion Anchors: Insert wedge-type attachments with pullout and shear capacities appropriate for supported loads and building materials.

### 2.3 VIBRATION ISOLATION

A. Vibration Supports:

1. Pads: Arranged in single or multiple layers of oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass of sufficient stiffness for uniform loading

over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

2. Mounts: Double-deflection type, with molded, oil-resistant fiberglass, rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and baseplate for bolting to structure. Provide isolator with minimum 0.5-inch static deflection.
3. Spring Isolators: Freestanding, laterally stable, restrained or open-spring isolators. Provide isolator with minimum 1-inch static deflection.

B. Vibration Hangers:

1. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Provide isolator with minimum 0.5-inch static deflection.
2. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression. Provide isolator with minimum 1-inch static deflection.

## 2.4 PRESSURE GAGES AND TEST PLUGS

A. Pressure Gages: Direct-mounting, indicating-dial type complying with ASME B40.100. Dry metal case, minimum 2-1/2-inch diameter with red pointer on white face, and plastic window. Minimum accuracy 3 percent of middle half of range. Range two times operating pressure.

B. Test Plug: Corrosion-resistant brass or stainless-steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating 500 psig at 200 deg F.

# PART 3 - EXECUTION

## 3.1 MOTOR INSTALLATION

A. Anchor motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions.

## 3.2 GENERAL PIPING INSTALLATIONS

A. Install piping free of sags and bends.

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

C. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.

E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.

F. Install unions at final connection to each piece of equipment.

G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.

H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

## 3.3 GENERAL EQUIPMENT INSTALLATIONS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

I. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

J. Install equipment to allow right of way for piping installed at required slope.

## 3.4 HANGERS AND SUPPORTS

A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.

B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.

C. Install powder-actuated drive-pin fasteners in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

D. Install mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.

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

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

3.5 VIBRATION ISOLATION

A. Adjust vibration isolators to allow free movement of equipment limited by restraints.

B. Install resilient bolt isolation washers and bushings on equipment anchor bolts.

I. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

END OF SECTION 23 05 00

# SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. [Fire-resistance-rated, watertight ] [Watertight ]sleeve-seal systems.
4. Grout.

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Presealed Systems, LLC; Hydro Preseal, or a comparable product.

2. Outer Sleeves: [EPDM] [NBR] <Insert other> attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
3. Water Stop Mid-body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve. <Describe size and type of pipe to be inserted in sleeve seal>.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] or comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

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

1. Sealing Elements: [EPDM-rubber] [NBR] 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] [Plastic] [Stainless steel].
3. Connecting Bolts and Nuts: [Carbon steel, with corrosion-resistant coating,] [Stainless steel] of length required to secure pressure plates to sealing elements.

2.3 [FIRE-RESISTANCE-RATED, ]WATERTIGHT SLEEVE-SEAL SYSTEMS

A. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Presealed Systems, LLC; Hydroflame Sleeve, or a comparable product.

2. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
3. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.

4. Provide a two-hour fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

B. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Presealed Systems, LLC; Hydroflame CMD Metal Deck Device, or a comparable product.

2. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
3. Includes a cone attached to the base for extending the device through the metal deck and a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.

4. Provide a two-hour fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

C. Description: Cast-in-place, watertight tub box drain block out firestop device for use in floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke and fire, and hot gasses.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Presealed Systems, LLC; Hydroflame Tub Box, or a comparable product.

2. Consists of a reinforced polymer box containing a 2-1/2-inches (63.5 mm) thick polystyrene foam insert with an upper water seal consisting of absorbent material and a pitched water trough.
3. Include a sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
4. Include two support legs each with a radial extended flange for balance and for fastening to concrete formwork, and a lower water-seal and radial extended flange attached to the lower end of the sleeve for fastening to concrete formwork and a waterstop gasket with three concentric raised rings for embedment and sealing to the concrete slab.

5. Provide a two-hour fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

## 2.4 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 (34.5-MPa), 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 (25-mm)] annular clear space between piping and concrete slabs and walls.

1. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.

2. 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. 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 (50 mm)] above finished floor level.

2. 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 (6.4-mm) 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 Division 07 Section "Joint Sealants."
4. 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 Division 07 Section "Penetration Firestopping."Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

## 3.2 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.

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.

1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Position cast-in-place water tight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.

1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve.

## 3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use [sleeves and sleeve seals] [cast-in-place watertight sleeve seals] [fire-resistance-rated cast-in-place watertight sleeve seals] for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping [NPS 6 (DN 150)] <Insert pipe size> and Smaller: Presealed Systems LLC; Hydropreseal.

b. Piping Smaller Than [NPS 6 (DN 150)] <Insert pipe size>: [Cast-iron wall sleeves] [Galvanized-steel wall sleeves] [Galvanized-steel-pipe sleeves] <Insert material>.
c. Piping [NPS 6 (DN 150)] <Insert pipe size> and Larger: [Cast-iron wall sleeves] [Galvanized-steel wall sleeves] [Galvanized-steel-pipe sleeves] <Insert material>.

2. Exterior Concrete Walls below Grade:

a. Piping [NPS 6 (DN 150)] <Insert pipe size> and Smaller: Presealed Systems LLC; Hydropreseal.

b. Piping Smaller Than [NPS 6 (DN 150)] <Insert pipe size>: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] <Insert material>.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

c. Piping [NPS 6 (DN 150)] <Insert pipe size> and Larger: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] <Insert material>.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping [NPS 6 (DN 150)] <Insert pipe size> and Smaller: Presealed Systems LLC; Hydropreseal.

b. Piping Smaller Than [NPS 6 (DN 150)] <Insert pipe size>: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] <Insert material>.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

c. Piping [NPS 6 (DN 150)] <Insert pipe size> and Larger: [Cast-iron wall sleeves with sleeve-seal system] [Galvanized-steel wall sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves with sleeve-seal system] [Galvanized-steel-pipe sleeves] <Insert material>.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping [NPS 6 (DN 150)] <Insert pipe size> and Smaller: Presealed Systems LLC; [Hydroflame Cast-in-Place Sleeve] [Hydroflame Tub Box].

b. Piping Smaller Than [NPS 6 (DN 150)] <Insert pipe size>: [Galvanized-steel-pipe sleeves] [PVC-pipe sleeves] <Insert material>.

c. Piping [NPS 6 (DN 150)] <Insert pipe size> and Larger: [Galvanized-steel-pipe sleeves] [PVC-pipe sleeves] <Insert material>.

5. Interior Partitions:

a. Piping Smaller Than [NPS 6 (DN 150)] <Insert pipe size>: [Galvanized-steel-pipe sleeves] [PVC-pipe sleeves] <Insert material>.

b. Piping [NPS 6 (DN 150)] <Insert pipe size> and Larger: [Galvanized-steel-sheet sleeves] <Insert material>.

END OF SECTION 23 0517

# SECTION 23 0523 - GENERAL DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes the following Valves:

1. Gate valves.
2. Ball valves.
3. Plug valves.
4. Butterfly valves
5. Swing check valves.
6. Wafer check valves.
7. Lift check valves.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design this project element, including comprehensive engineering analysis by a qualified design professional, to meet or exceed the program requirements, performance requirements, code compliance, applicable ASTM quality standard, and design criteria as outlined and / or referenced within this RFP package.

### 1.4 SUBMITTALS

A. Not used.

### 1.5 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.2 VALVES

A. General duty valves in cast iron, bronze and brass, fabricated to comply with Manufacturer's Standardization Society ( MSS ) classification listed. Gate, globe, ball, butterfly and plug valves for shutoff duty; globe, ball and plug valves for throtlling duty.

1. Gate valves, 2-inch and smaller, for Chilled Water, Domestic Hot and Cold Water service: MSS SP-80, Class 125 or Class 150, cast bronze, threaded or soldered ends, based upon service requirements.
2. Gate valves, 2-inch and smaller, for Heating Hot Water, Steam service: MSS SP-80, Class 150, cast bronze, threaded or soldered ends, based upon service requirements.
3. Gate valves, 2 1/2-inch and larger: MSS SP-70, Class 125, iron body, flanged ends.
4. Ball valves, 1-inch and smaller: Rated for 150 psi saturated steam service, 400 psi water-oil-gas ( WOG ) service, 2-piece construction, bronze body, threaded or soldered ends, based upon service requirements.
5. Ball valves, 1 1/4-inch to 2-inch: Rated for 150 psi saturated steam service, 400 psi WOG, 3-piece construction, bronze body, threaded or soldered ends, based upon service requirements.
6. Plug valves, 2-inch and smaller: Rated at 150 psi WOG, bronze body, threaded ends.
7. Plug valves, 2 1/2-inch and larger: MSS SP-78, rated at 175 psi WOG, semi-steel body, flanged ends.
8. Globe valves, 2-inch and smaller: MSS SP-80, Class 125 or Class 150, cast bronze.
9. Globe valves, 2 1/2-inch and larger: MSS SP-85, Class 125, iron body.
10. Butterfly valves, 2 1/2-inch and larger: MSS SP-67, rated at 200 psi, cast iron body, field replaceable sleeve, stainless steel stem, lug or wafer type, based upon service requirements.
11. Swing check valves, 2-inch and smaller: MSS SP-80, Class 125 or Class 150, cast iron body and cap, threaded or soldered ends, based upon service requirements.
12. Swing check valves, 2 1/2-inch and larger: MSS SP-71, Class 125, cast iron body and cap, flanged ends.
13. Wafer check valves: Class 250, cast iron body, to open with one foot differential pressure.
14. Lift check valves, 2-inch and smaller: Class 125, cast bronze body and cap, threaded ends.
15. Gate valves, 2-inch and smaller: Used for general shutoff application on all High Temperature Hot Water systems shall be Class 600 psi, ASTM A-216-WCB steel body and bonnet, with 600 psi socket weld ends, solid disc, copper-silicon alloy stem, brass packing gland, Teflon(r) impregnated packing, and malleable iron handwheel. Provide Class 600 psi valves meeting the above specifications where system operating pressure and test pressures allow.
16. Gate valves, 65-mm and larger: Used for shutoff application on all High Temperature Hot Water systems shall be Class 600, ASTM A-216-WCB steel body, mounted, with body and bonnet conforming to ASTM A-216-WCB with flanged ends, Teflon(r) impregnated packing and two piece backing gland assembly, with mose ends, flex wedge, inside screw, rising stem and provided cap and chain. Grease fittings shall be supplied for shaft packing.
17. Ball valves, 1-inch and smaller: Class 600 psi, two piece construction, with steel body conforming to ASTM B62, conventional port, chrome plated brass ball , replaceable

Teflon(r) or TFE seats and seals, blowout-proof stem and vinyl covered steel handle. Provide solder ends for hot water service. Provide socket weld ends on medium and high pressure steam and condensate service valves.

18. Ball valves, for hot water service, to 6-inches: Class 600 psi, three piece construction, with steel body conforming to ASTM B62, conventional port, chrome plated brass ball , replaceable Teflon(r) or TFE seats and seals, blowout-proof stem and vinyl covered steel handle. Provide socket weld ends for high temperature hot water service. Ball seats and stem must be easily replaced without removing valve pipe connections from line. Leakproof at all pressures up to 600 psi. Construction of valve shall allow for actuator, if needed. Valve stem shall be blowout proof.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner to engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in compliance with CO-7 DB section 16.

END OF SECTION 23 0523

# SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes hangers and supports for mechanical systems piping and equipment.

### 1.3 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

### 1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of hanger and support.

C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

D. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

### 1.5 QUALITY ASSURANCE

A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.

C. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURED UNITS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi (690-kPa) average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

## 2.2 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36 (ASTM A 36M), steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, nonshrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

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

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

C. Install supports with maximum spacings complying with MSS SP-69.

D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.

F. Install concrete inserts in new construction prior to placing concrete.

G. Install powder-actuated drive-pin fasteners 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. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.

H. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100 mm) thick.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

K. Support fire protection systems piping independent of other piping.

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

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

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

O. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees (3.1 rad) and have dimensions in inches (mm) not less than the following:

4. Pipes 8 Inches (DN 200) and Larger: Include wood inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

## 3.3 EQUIPMENT SUPPORTS

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

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

## 3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe 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 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of 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 by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 9 Section "Painting."

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

END OF SECTION 23 0529

# SECTION 23 0548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings, Contract Provisions, Special Provisions, Division 00 Supplementary Conditions, and Division 01 Specification Sections apply to this Section.

### 1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Elastomeric hangers.
4. Pipe riser resilient supports.

### 1.3 DEFINITIONS

A. IBC: 2003 International Building Code.

B. ICC-ES: ICC-Evaluation Service.

### 1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

### 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to the COTR.

B. Comply with seismic-restraint requirements in the VUSBC 2003 unless requirements in this Section are more stringent.

## PART 2 - PRODUCTS

### 2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

C. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

Verify availability of various pad materials with manufacturers.

1. Resilient Material: Oil- and water-resistant neoprene rubber.

D. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

### 2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

### 3.2 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Sheet Metal Roofing Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

### 3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust restraints to permit free movement of equipment within normal mode of operation.

### 3.4 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported or Suspended Equipment:

1. Garage A: Basement Mechanical Room - Chilled Water Pumps: 1" thick neoprene pads.
2. Provide neoprene vibration isolation pipe hangers within 10 feet of each pump.
3. Chilled water pipe riser isolation - 1" thick neoprene pads.
4. Garage B/C: 1" thick neoprene pads for Unit No. 1 serving elevator machine room, condensing units on roof, and roof mounted heat pump a/c unit on vibration isolation mounts.

B. B/C Garage Tower Roof:

1. Neoprene pads 1" thick for each condensing unit.

PART 4 - FIELD QUALITY CONTROL

A. Conform to all applicable provisions of Division 01 section, "Quality Requirements."

B. The following describes the minimum inspection and testing required in the Contractor's Quality Control (CQC) Plan and Program for the work of this section and is for CQC only. The implementation of the Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide the work in accordance with the Contract Documents, applicable codes, regulations and governing authorities. The CQC plan and program shall include, but not be limited to, the testing and inspection elements specified herein and in all applicable Division 00 and Division 01 specifications. These elements are provided only as a minimum starting point for the contractor to use to generate his complete CQC Program. The contractor shall engage an independent testing agency to perform specified sampling, testing, and inspections, meeting all requirements specified herein.

END OF SECTION 23 0548

# SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## Part 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Identifying Devices and Labels

B. Related Sections:

1. Section 23 05 00 (15050) - Common Work Results for HVAC

### 1.2 SUBMITTALS

A. Submit "Letter of Conformance" in accordance with section 01 33 00 (01330) indicating specified items selected for use in Project with the following supporting data:

1. Product Data: For identification materials and devices.
2. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

### 1.3 QUALITY ASSURANCE

A. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

### 1.4 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

## Part 2 - PRODUCTS

### 2.1 GENERAL

A. General: Products specified are for applications referenced in other Division 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Pipes Including Insulation: Full-band pipe markers, extending 360 degrees around pipe at each location.

### 2.2 IDENTIFYING DEVICES AND LABELS

A. Lettering: Manufacturer's standard preprinted captions as selected by Owner's Representative.

B. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.

C. Plastic Duct Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cold-air supply.
2. Yellow: Hot-air supply.
3. Blue: Exhaust, outside, return, and mixed air.
4. Terminology: Include direction of airflow; duct service such as supply, return, and exhaust; duct origin, duct destination, and design flow.

D. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

E. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch thick, polished brass.
2. Size: 1-1/2-inches diameter, unless otherwise indicated.

F. Valve Tag Fasteners: Brass, wire-link chain and S-hooks.

G. Access Panel Markers: 1/16-inch thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.

H. Valve Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include screws.

1. Frame: Extruded aluminum.
2. Glazing: ASTM C1036, Type I, Class 1, Glazing quality B, 2.5-mm, single-thickness glass.

I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

Part 3 - EXECUTION

## 3.1 LABELING AND IDENTIFYING PIPING SYSTEMS

A. Install pipe markers on each system as indicated below. Include arrows showing normal direction of flow.

1. Gas.
2. Condensate.
3. Vent.
4. Chilled Water Supply
5. Chilled Water Return
6. Heating Hot Water Supply
7. Heating Hot Water Return
8. Condenser Water Supply
9. Condenser Water Return

B. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.

C. Fasten markers on pipes and insulated pipes by one of following methods:

1. Snap-on application of pretensioned, semirigid plastic pipe marker.

D. Locate pipe markers where piping is exposed in machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations according to the following:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
3. Near penetrations through walls, floors, ceilings, or nonaccessible 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 a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

## 3.2 VALVE TAGS

A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.

B. Valve Tag Application Schedule: Tag valves according to size, shape, color scheme, and with captions similar to those indicated in the following:

1. Chilled Water
2. Heating Hot Water

3. Condenser Water

C. Tag Material: Brass.

D. Tag Size and Shape: According to the following:

1. Cold Water: 1-1/2 inches round.
2. Hot Water: 1-1/2 inches round.
3. Gas: 1-1/2 inches round.

E. Install framed valve schedule in each major mechanical equipment room.

F. Valve schedule and tag locations shall be shown on record drawings.

3.3 LABELING AND IDENTIFYING DUCT SYSTEMS.

A. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.

1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING AND CLEANING

A. Relocate HVAC identification materials and devices that have become visually blocked by work of this or other Divisions.

B. Clean faces of identification devices and glass frames of valve charts

END OF SECTION 22 0553

# SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

### 1.1 SECTION REQUIREMENTS

A. This Section includes testing and balancing to produce design objectives for air systems.

B. Certified Reports: Submit three copies of reports prepared, as specified in this Section, on approved forms certified by test and balance firm.

C. TAB Firm Qualifications: Engage a TAB firm certified by NEBB or AABC.

D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper test and balance of systems and equipment.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

D. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

E. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

F. Examine HVAC equipment to ensure that clean filters have been installed, belts are aligned and tight, and equipment with functioning controls is ready for operation.

G. Examine automatic temperature system components to verify the following:

1. Integrity of dampers and valves for free and full operation and for tightness of fully closed and fully open positions.
2. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
3. Sensors are located to sense only the intended conditions.
4. Controller set points are set at indicated values.

5. Interlocked systems are operating.
6. Changeover from heating to cooling mode occurs according to indicated values.

H. Report deficiencies discovered before and during performance of test and balance procedures.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

E. After testing and adjustments procedures have been completed, a system checkout shall be performed with the balancer present. A representative of RAC shall be given 48 hours notice that the system is ready for final checkout and inspection. Any defects found in the work shall be corrected.

F. Automatic temperature control systems shall be adjusted, tested and in operation to assure satisfactory operation.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare schematic diagrams of systems' "as-built" duct layouts.

B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

C. Verify that motor starters are equipped with properly sized thermal protection.

D. Check for airflow blockages.

E. Check condensate drains for proper connections and functioning.

F. Check for proper sealing of air-handling unit components.

G. Check for proper sealing of air duct system.

H. Adjust pulleys, and sheaves as required.

3.4 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 5 percent.

END OF SECTION 20 0593

# SECTION 23 0700 - HVAC INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
B. Types of mechanical insulation specified in this section include the following:

1. Piping System Insulation:
    a. Fiberglass
    b. Cellular Glass.
    c. Flexible Unicellular.
    d. Flexible Unicellular (exterior application shall include UV protection and Aluminum jacket with weather-proof construction.

2. Ductwork System Insulation:
    a. Fiberglass.
    b. Flexible Unicellular.

3. Equipment Insulation:
    a. Fiberglass.
    b. Flexible Unicellular.

C. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 23 section "Supports and Anchors" for protection saddles, protection shields, and thermal hanger shields; not work of this section.
2. Division 23 section "Metal Ducts" for duct linings; not work of this section.
3. Division 23 section "Mechanical Identification" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

### 1.2 SUBMITTALS

A. Refer to Section Division 23 "Basic Mechanical Requirements."

B. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

### 1.3 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project.
B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division 23 Section "Basic Mechanical Requirements."

B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

## PART 2 – PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

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

1. ArmaCell.
2. CertainTeed Manson.
3. Knauf Fiber Glass GmbH.
4. Johns Manville.
5. Owens-Corning Fiberglass Corp.
6. Pittsburgh Corning Corp.
7. Rubatex Corp.
8. Reflectix.

### 2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.

B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2.

C. Flexible Unicellular Piping Insulation: ASTM C 534, Type I.

D. Jackets for Piping Insulation: ASTM C 1136, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. Encase fiberglass pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
2. Encase all exposed pipe insulation in occupied rooms with PVC pipe covers.

    a. Thickness shall be 30 mil from floor level to 9 feet above finished floor. Otherwise, thickness shall be 20 mil.
    b. Bond all PVC seams in occupied rooms with polyco VP adhesive, or equal. Bond adhesive shall conform to ASTM D-2654.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

G. Removable/Reusable Insulation Valve Covers: Two piece, silicone impregnated finish, Type E glass fiber insulation. Multiglas Products Co., MULTI COV-R, or approved equal.

2.3 DUCTWORK INSULATION MATERIALS

A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class 1, 6 LBS/FT3.

B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, Class B-4, 1.5 LBS/FT3.

C. Fire rated ductwork insulation. Unifrax Firewrap or approved equal. Blanket shall be manufactured from calcia, magnesia, silica chemistry designed to enhance biosolubility, 8 lb/cubic feet, ASTM E84 with flame spread less than 25 and smoke developed rating less than 50.

1. Fire rated insulation installation materials: Sodium silicate glue, 1/2" steel bands.

D. Jackets for Ductwork Insulation: Foil-Skrim-Kraft (FSK) ASTM C 1136, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.

E. Ductwork Insulation Accessories: Provide staples, bands, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

F. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.4 EQUIPMENT INSULATION MATERIALS

A. Rigid Fiberglass Equipment Insulation: ASTM C 612, Class 2, 6 LBS/FT3.

B. Flexible Fiberglass Equipment Insulation: ASTM C 553, Type II, Class F-1,4.5 LBS/FT3.

C. Flexible Unicellular Equipment Insulation: ASTM C 534, Type II.

D. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or aluminum jacket at Installer's option, except as otherwise indicated.

E. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastic and protective finishes as recommended by insulation manufacturer for applications indicated.

F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on unions, flexible connections, and expansion joints.

B. Cold Piping (below 40 deg. F) Application Requirements: Insulate the following sub-freezing HVAC piping systems:

1. Refrigerant suction lines between evaporators and compressors.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1 inch thick for pipe sizes up to and including 1 inch, 1-1/2 inch thick for pipe sizes over 1 inch.
b. Flexible Unicellular: 1 inch thick for pipe sizes up to and including 1 inch (largest size permitted).

C. Cold Piping (40 degree F to 60 degree F) Application Requirements: Insulate the following cold HVAC piping systems:

1. HVAC chilled water supply and return piping.
2. HVAC dual temperature water supply and return piping.
3. HVAC make-up water piping.
4. Air conditioner condensate drain piping.
5. Chemical feed piping.
6. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1 inch thick for pipe sizes up to 1 inch, 1-1/2 inch thick for pipe sizes 1-1/4 inch and larger.

D. Hot Piping (to 200 deg. F) Application Requirements: Insulate the following HVAC piping systems:

1. HVAC hot water supply and return piping.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1 inch thick for pipe sizes up to 1 inch, 1-1/2 inch for pipe sizes 1-1/4 inch up to and include 4 inch, 2 inch thick for pipes 5 inch and larger.

3.3 DUCTWORK SYSTEM INSULATION

A. Insulation Omitted: Do not insulate the following ductwork:

1. Fibrous glass ductwork.
2. Lined ductwork.
3. Exposed ductwork installed within conditioned spaces (excluding mechanical rooms).

B. Ductwork Application Requirements: Insulate the following ductwork:

1. Outdoor exposed duct flanges-single wall and double wall. Provide rigid insulation on all exposed flanges prior to covering with Alumagard wrap.
2. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
3. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.
4. HVAC return ductwork in mechanical equipment rooms or installed outdoors.
5. HVAC plenums and unit housings not pre-insulated at factory or lined.
6. Exhaust fan and gravity relief plenums and ductwork 10 feet in all directions below roof. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:

    a. Rigid Fiberglass: 2 inch thick, for indoor exposed ductwork; 3” thick for exterior ductwork.
    b. Flexible Fiberglass: 2 inch thick, application limited to indoor concealed locations.

C. Ductwork penetrating 2-hour fire separation; provide fire rated insulation where indicated and as required to maintain fire rating integrity.

D. All exposed ductwork, insulated or uninsulated, shall be covered per section 3.8.

3.4 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature) Application Requirements: Insulate the following cold equipment:

1. Refrigeration equipment, including chillers, tanks and pumps.
2. Drip pans under chilled equipment.
3. Cold and chilled water pumps.
4. Air separators.
5. Expansion tanks
6. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

    a. Fiberglass: 1 inch thick for surfaces above 40 deg. F (2 deg. C) and 1-1/2 inch thick for surfaces 40 deg. F (2 deg. C) and lower.
    b. Flexible Unicellular: 1-1/2 inch thick.

B. Hot Equipment (Above Ambient Temperature) Application Requirements: Insulate the following hot equipment:

1. Air separators.
2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2 inch thick.

3.5 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings, air separators and all other piping system components 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.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 inch wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.

I. Provide removable valve covers for valves which must be accessed periodically.

3.6 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

F. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

G. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

H. Fire rated duct insulation: Wrap blanket around duct and provide 1/4 inch bands at 12 inch centers. Completely install per manufacturer’s instructions to obtain 2-hour fire resistance rating.

## 3.7 INSTALLATION OF EQUIPMENT INSULATION

A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

D. Do not apply insulation to equipment, breechings, or stacks while hot.

E. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, trawled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inch. Apply over vapor barrier where applicable.

H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, accessories and pumps.

## 3.8 OUTDOOR INSULATION FINISH

A. General: Piping, ductwork and equipment exposed to weather shall have insulation protective finish or jacketing installed as recommended by manufacturer.

B. Piping: Shall have a 0.020 inch minimum thickness PVC jacket with moisture barrier with locking longitudinal seam and butt straps. Fittings, valves, flanges, etc., shall have factory or job fabricated PVC cover secured with banking and/or screws.

C. Round ductwork: Same finish as piping.

D. Rectangular Ductwork and Equipment: Shall have a laminated jacketed system Alumaguard 60 by Polyguard Products, Inc., or approved equal. The laminated jacketing system shall be 60 mil thick, and shall consist of a rubberized bitumen compound, heat applied to a cross-laminated high strength polyethylene film, laminated to aluminum foil.

## 3.9 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 0700

# SECTION 23 0713 - DUCT INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Resin-bonded fiber glass duct insulation.

### 1.2 REFERENCES

A. ASTM International:

1. ASTM C411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
2. ASTM C1104/C1104M Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
3. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
4. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
5. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. National Fire Protection Association (NFPA):

1. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. North American Insulation Manufacturers Association (NAIMA):

1. AH100 Fibrous Glass HVAC Duct Systems: Proven Performance.

D. Underwriters Laboratories, Inc. (UL):

1. UL 181 Factory-Made Air Ducts and Air Connectors.
2. UL 723 Test for Surface Burning Characteristics of Building Materials.

E. Underwriters' Laboratories of Canada (ULC):

1. CAN/ULC-S102-M Test for Surface Burning Characteristics of Building Materials.

### 1.3 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Stiffness: Specified value (product of Young's modulus of elasticity and moment of inertia) when tested in accordance with NAIMA AH100.
2. Service Temperature (ASTM C411): Up to 250 degrees F (121 degrees C).
3. Maximum Air Velocity (UL 181): 5000 feet per minute (1524 mpm).

4. Maximum Internal Static Pressure (UL 181): Plus or minus 2 inches (51 mm) of water or 498 Pa.
5. Water Vapor Transmission (ASTM E96): Less than 0.02 perms.
6. Water Vapor Absorption (ASTM C1104): Less than 3 percent by weight.
7. Microbial Growth (ASTM G21 and UL 181): Does not promote or support the growth of mold, fungi or bacteria.
8. Surface Burning Characteristics of FSK-Faced Insulation (ASTM E84, CAN/ULC-S102-M, NFPA 255 and UL 723):

    a. Flamespread: 25, maximum.
    b. Smoke Developed: 50, maximum.

1.4 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 01 Submittal Procedures Section.

B. Product Data: Submit product data, including manufacturer's SPEC-DATA sheet, for specified products.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements and Approvals: [Specify applicable requirements of regulatory agencies.].

1. [Code agency name].

    a. [Report or approval number].

B. Qualifications:

1. Manufacturer Qualifications: Minimum of 10 years experience in manufacturing building insulation products.

1.6 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 01 Product Requirements Section.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Handling: Handle materials to prevent bending, warping, twisting and surface damage.

D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

PART 2 - PRODUCTS

2.1 DUCT INSULATION

A. Manufacturer: Knauf Insulation.

1. Contact: One Knauf Dr., Shelbyville, IN 46176; Telephone: (800) 825-4434, (317) 398-4434; Fax: (317) 398-3675; website: www.KnaufInsulation.us.

B. Substitutions: No substitutions permitted.

## 2.2 MATERIALS

A. Eclipse Air Duct Board:

1. Thickness: [1 inch (25.4 mm)] [1.5 inches (38 mm)] [2 inches (51 mm)].
2. Size: [48 inches wide x 96 inches long (1219 x 2438 mm)] [48 inches wide x 120 inches long (1219 x 3048 mm)].
3. Edge: [Butt] [Shiplap].
4. Stiffness: [EI-475] [EI-800].

# PART 3 - EXECUTION

## 3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

## 3.2 EXAMINATION

A. Site Verification of Conditions: Verify that substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

## 3.3 INSTALLATION

A. Fit insulation to form a complete, tight-fitting thermal barrier around required areas.

## 3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch up, repair or replace damaged products prior to Substantial Completion.

END OF SECTION 20 0713

SECTION 23 0100 – HVAC CONTROLS

## 1.0 PART 1 - PRODUCTS

### 1.1 SOFTWARE

#### 1.1.1 OPERATOR INTERFACE

A. Description. The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and a standalone web server operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. Operators with sufficient access level shall have an ability to make changes to all system and equipment graphics in the web server in addition to having full DDC system access to make configuration changes to the control system. Any tools required for making graphic changes shall be provided with web server.

B. Operator Interface. Furnish one Web server interface. Operators shall be able to access all necessary operational information in the DDC system via client computer utilizing web browser.
1. Web server shall connect via the LAN and be able to simultaneously serve up controller information to multiple operators connected via LAN with web browsers. Each client web browser connected to server shall be able to access all system information.
2. With the use of a remote SMTP email server the operators interface web server shall be able to notify personnel of an alarm or record information about an alarm in the DDC system.
3. Secondary interface, in addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone and tablet devices. As a minimum, the following capabilities shall be provided through this interface:
    a. Secondary interface with screen resolution 1024x768 and above shall be able to provide a full graphical environment as the primary interface.
    b. Secondary interface with screen resolution lower than 1024x768 may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:
        1) An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
        2) The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
        3) A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
        4) Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.

C. Web Server Hardware. Furnish one web server with Ethernet port for LAN or direct operator client computer access. The web server shall be capable of communicating to the peer to peer DDC controller network. Any required installation or commissioning software shall be pre-installed on the web server. Installation or commissioning of the web server shall be done through a client computer with a standard web browser.

D. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

E. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
1. Log In and Log Out. System shall require user name and password to log in to operator interface.
2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as set points, PID gains, on and off controls, and sensor calibration.
4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms. Remote users shall be able to receive alarms via emails or cell phone text messages.
6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

F. System Software.
1. Operating System and required software. Web server operator interface shall be a self-contained web server without the need for any type of maintenance.
2. System Graphics. Operator interface shall be graphical and shall include at least one graphic per piece of equipment or occupied zone, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
    a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins.

G. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard Windows compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each web server shall internally store a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
   a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
   b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
   c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs.

Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
    a. Standard Reports. Furnish the following standard system reports:
        1) Reports shall be filtered based upon the selected equipment
        2) Alarm Reports
            a) Alarm Summary - Current alarms
            b) Alarm Sources – List of equipment and associated alarm conditions
            c) Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
        3) Schedule Reports
            a) Effective Schedules – Displays effective schedules for each equipment
            b) Schedule Instances – Displays all schedules entered
        4) Security Reports – Maintains audit of all actions taken through user interface
        5) Commissioning Reports – Provide equipment checkout status and notes
        6) Equipment Reports – Provide reports showing trended points and available network points
    b. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
14. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
15. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

H. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

END OF SECTION 23 0900

# SECTION 23 1123 – FACILITY NATURAL-GAS / PROPANE PIPING

## Part 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes

1. Materials and installation for piping, valves and fittings for gas fired equipment.

### 1.2 RELATED SECTIONS

A. Section 01 33 00 - Submittal Procedures.

B. Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

C. Section 01 78 00 - Closeout Submittals.

D. Section 01 45 00 - Quality Control

### 1.3 REFERENCES

A. Codes and standards referenced in this section refer to the latest edition thereof.

B. American Society of Mechanical Engineers (ASME)

1. ASME B16.5, Pipe Flanges and Flanged Fittings
2. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
3. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
4. ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.

C. American Society for Testing and Materials International (ASTM)

1. ASTM A 47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A 53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
3. ASTM B 75M, Standard Specification for Seamless Copper Tube (Metric).
4 . ASTM B 837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

D. Canadian Standards Association (CSA International).

1. CSA W47.1, Certification of Companies for Fusion Welding of Steel.

E. Canadian Standards Association (CSA) / Canadian Gas Association (CGA)

1. CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
2. CAN/CSA B149.2, Propane Storage and Handling Code.

F. Health Canada/Workplace Hazardous Materials Information System (WHMIS)

1. Material Safety Data Sheets (MSDS)

1.4 SUBMITTALS

A. Submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Product Data:

1. Submit manufacturer's printed product literature, specifications and datasheet for piping, fitting and equipment.
2. Indicate on manufacturer's catalogue literature following: valves.
3. Submit WHMIS MSDS in accordance with Section 02 62 00.01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
4. Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
5. Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
6. Instructions: Submit manufacturer's installation instructions.
7. Closeout Submittals: Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

A. Pre-Installation Meeting:

1. Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.

a. Verify Project requirements.
b. Review Installation and substrate conditions.
c. Co-ordination with other building subtrades.
d. Review manufacturer's installation instructions and warranty requirements.

2. Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

3. Trades people to have journeyperson qualifications.

1.6 DELIVERY, STORAGE AND HANDLING

A. Waste Management and Disposal:

1. Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction /Demolition Waste Management and Disposal.
2. Remove from site and dispose of packaging materials at appropriate recycling facilities.
3. Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

4. Separate for reuse and recycling and place in designated containers, steel, metal , plastic waste in accordance with WMP.
5. Divert unused metal materials from landfill to metal recycling facility as approved by Engineer/Architect.

Part 2 – PRODUCTS

2.01 PROPANE PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.

1. Fittings: ASTM A234/A234M, wrought steel welding type, with AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
2. Joints: ASME B31.1, welded.

B. Polyethylene Pipe: ASTM D2513, SDR 11.

1. Fittings: ASTM D2683 or ASTM D2513 socket type.
2. Joints: Fusion welded.

2.02 PROPANE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
1. Fittings: ASTM A234/A234M, wrought steel welding type.
2. Joints: ANSI Z223.1, welded.
3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half lapped 10 mil (0.25 mm) polyethylene tape.

2.03 PROPANE PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: Threaded or welded to ASME B31.1.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:

1. Ferrous pipe: Class 150 malleable iron threaded unions.

2.05 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

2.06 BALL VALVES

A. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

Part 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions and datasheet.

3.2 PIPING

A. Install piping in accordance Section 23 05 05 - Installation of Pipework, applicable Provincial Codes, CAN/CSA-B149.1, supplemented as specified.

B. Slope piping down in direction to flow to low points.

C. Install drip points:

1. At low points in piping system and where indicated.
2. Provide complete with blowdown valve i.e. manual shut-off valve as specified above.
3. Minimum 75 mm in length from tee connection in riser to top of valve. Size to be minimum NPS 3/4. Provide complete with threaded end cap.
4. Use eccentric reducers at pipe size change installed to provide positive drainage.
5. Provide clearance for access and for maintenance.
6. Ream pipes, clean scale and dirt, inside and out.
7. Install piping to minimize pipe dismantling for equipment removal.
8. Field ending of piping to be prohibited.
9. Nesting of bushings to be prohibited. Utilize properly sized reducing fittings.
10. Do not utilize propane piping as an electrical ground.

3.3 VALVES

A. Install valves with stems upright or horizontal unless approved otherwise by Engineer/Architect.

B. Install valves as indicated.

3.4 FIELD QUALITY CONTROL

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A. Site Tests/Inspection:

1. Test system in accordance with CAN/CSA B149.1 and CAN/CSAB149.2 and requirements of authorities having jurisdiction.

B. Manufacturer's Field Services:

1. Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with contract.
2. Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
3. Schedule site visits to review work at stages listed:

a. After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
b. Twice during progress of work at 25% and 60% complete.
c. Upon completion of work, after cleaning is carried out.

C. Obtain reports within 3 days of review and submit immediately to Engineer/Architect

D. Performance Verification:

1. Refer to Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

E. PV procedures:

1. Test performance of components.

3.5 ADJUSTING

A. Purging: purge after pressure test in accordance with CAN/CSA B149.1 and CAN/CSA B149.2.

B. Pre-Start-Up Inspections:

1. Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
2. Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

A. Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

B. Perform cleaning operations as specified in Section 01 74 11 - Cleaning, and in accordance with manufacturer's recommendations.

C. Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 PURGING

A. Purge after pressure test in accordance with CSA-B149.1.

3.8 IDENTIFICATION

A. Identify new propane piping systems in accordance with requirements for CSA-B149.1.

B. Above ground propane piping to be primed and painted yellow along its entire length. All below ground propane piping to be covered with plastic yellow identification marker tape suitable for direct burial.

C. Supply and install "Propane Gas" pipe identification markers along length of propane piping installation in accordance with CSA-B149.1 and Section 23 05 53 01 - Mechanical Identification. Maximum spacing along straight length of pipe to be 6 m.

D. Maintain minimum depth of burial of underground propane piping of 600 mm, unless otherwise noted.

3.9 STORAGE CYLINDERS

A. Propane storage cylinder shall be supplied and installed by the Owner. This tank shall not be considered part of this contract.

B. The responsibility for connection of the propane storage cylinder to the propane distribution piping shall be borne by the Owner.

END OF SECTION 23 1123

SECTION 23 2300 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Comply with ASME B31.5, "Refrigerant Piping," and with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

PART 2 - PRODUCTS

2.1 TUBES AND FITTINGS

A. Copper Tube: ASTM B 88, Types K and L and ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

D. Brazing Filler Metals: AWS A5.8.

2.2 VALVES

A. Thermostatic Expansion Valve: Comply with ARI 750; forged brass or steel body, stainless-steel internal parts, copper tubing filled with refrigerant charge for 40 deg F suction temperature; 450-psig working pressure, and 240 deg F operating temperature.

B. Solenoid Valves: Comply with ARI 760; 240 deg F temperature rating, 400-psig working pressure, 240 deg F operating temperature; and 24-V normally closed holding coil.

2.3 REFRIGERANT PIPING SPECIALTIES

A. Strainers: Welded steel with corrosion-resistant coating and 100-mesh stainless-steel screen with socket ends; 500-psig working pressure and 275 deg F working temperature.

B. Moisture/Liquid Indicators: 500-psig operating pressure, 240 deg F operating temperature; with replaceable, polished, optical viewing window and color-coded moisture indicator.

E. Filter Dryers: 500-psig operating pressure; 240 deg F operating temperature; withgaskets, and filter-dryer cartridge.

F. Mufflers: Welded steel with corrosion-resistant coating and socket ends; 500-psig operating pressure; 240 deg F operating temperature.

G. Refrigerant: R-410A.

PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.

B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for wall penetration systems.

C. Install refrigerant piping and charge with refrigerant according to ASHRAE 15.

D. Belowground, install copper tubing in PVC conduit. Vent conduit outdoors.

E. Insulate suction lines to comply with Division 23 Section "HVAC Insulation."

F. 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.

G. Install solenoid valves upstream from each thermostatic expansion valve. Install solenoid valves in horizontal lines with coil at top.

H. Install thermostatic expansion valves as close as possible to distributors on evaporator coils.

I. 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.

J. Install strainers upstream from and adjacent to solenoid valves, thermostatic expansion valves, and compressors unless they are furnished as an integral assembly for device being protected:

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

## 3.2 PIPING SCHEDULE FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, Type K, or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, Type K, or Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

END OF SECTION 23 2300

SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.1 General:

A. Submittals: Submit product data on duct liner, sealing materials, and fire-stopping materials.

B. Comply with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

1.2 Products:

A. Sheet Metal Materials, General: Provide the following materials where indicated. Package and mark sheet metal materials as specified in ASTM A 700.

1. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90, mill phosphatized finish for exposed surfaces of ducts exposed to view.

2. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form, with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

B. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum ducts provide reinforcing of compatible materials.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

D. Duct Liner: Comply with NFPA Standard 90A and TIMA Standard AHC-101.

1. Materials: ASTM C 1071, Type II, with coated surface exposed to airstream to prevent erosion of glass fibers.

a. Thickness: 1/2 inch.
b. Thermal Performance: "K-Factor" equal to 0.28 or better, at a mean temperature of 75 deg F.
c. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.

2. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.
3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

b. Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

E. Joint and Seam Tape: 2 inches wide, glass-fiber-fabric reinforced.

F. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

G. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.

H. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

I. Hangers and Supports: Provide the following hanger and support components as indicated:

1. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
2. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

a. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.

3. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws, compatible with duct materials.
4. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
b. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

J. Rectangular Duct Fabrication: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

3. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

a. Supply Ducts: 3 inches water gage.
b. Return Ducts: 2 inches water gage, negative pressure.

c. Exhaust Ducts: 2 inches water gage, negative pressure.

4. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

K. Rectangular Duct Fittings: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1995 Edition, Figures 2-1 through 2-10.

L. Shop Application Of Liner In Rectangular Ducts: Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing. Butt transverse joints without gaps and coat joint with adhesive. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

1. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter, at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
2. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

a. Fan discharge.
b. Intervals of lined duct preceding unlined duct.

c. Upstream edges of transverse joints in ducts.

3. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

M. Round Duct Fabrication: Except where interrupted by fittings, provide round ducts in lengths not less than 12 feet.

1. Round Ducts: Fabricate exposed round supply ducts with spiral lockseam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.
2. Round Ducts: Fabricate concealed round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figure 3-1, RL-1, RL-4, or RL-5. Seams Types RL-2 or RL-3 may be used if spot-welded on 1-inch intervals. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

3. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.
4. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
5. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

    a. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.

        1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
        2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

            a) 3 to 26 inches: 24 gage.
            b) 27 to 36 inches: 22 gage.
            c) 37 to 50 inches: 20 gage.
            d) 52 to 60 inches: 18 gage.
            e) 62 to 84 inches: 16 gage.

        3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

            a) 3 to 14 inches: 24 gage.
            b) 15 to 26 inches: 22 gage.
            c) 27 to 50 inches: 20 gage.
            d) 52 to 60 inches: 18 gage.
            e) 62 to 84 inches: 16 gage.

        4) Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.
        5) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B, and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vanes.

    b. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
    c. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

d. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
e. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gage with 2-piece welded construction.
f. Round Gored Elbows Gages: Same as for nonelbow fittings specified above.
g. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
h. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gage.

1.3 Execution:

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Install ducts with the fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

J. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

K. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

M. Seam And Joint Sealing: Seal duct seams and joints as follows:

1. Pressure Classifications Greater Than 3 Inches Water Gage: All transverse joints, longitudinal seams, and duct penetrations.
2. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams.

3. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.
4. Seal externally insulated ducts prior to insulation installation.

N. Hanging And Supporting: Install and support ducts as follows unless indicated otherwise:

1. Rigid Round and Rectangular: As indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
2. Horizontal Ducts: Within 2 feet of each elbow and within 4 feet of each branch intersection.
3. Vertical Ducts: At a maximum interval of 16 feet and at each floor.
4. Upper Attachments To Structures: Allow for a load not exceeding 1/4 of the failure (proof test) load, but are not limited to the specific methods indicated.

5. Install concrete insert prior to placing concrete.

6. Install powder actuated concrete fasteners after concrete is placed and completely cured.

O. Connections: Make duct connections as specified below unless indicated otherwise:

1. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8.
2. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.
3. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

P. Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 23 3113

# SECTION 23 3300 - DUCT ACCESSORIES

## 1.1 GENERAL

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

1. Product data for backdraft dampers, manual volume control dampers, fire and smoke dampers, duct-mounted access panels and doors, and flexible ducts and connectors.
2. Shop drawings for special fittings and volume control damper installations and fire and smoke damper installations, including sleeves and duct-mounted access door and panel installations.

B. Quality Assurance: Comply with the following Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

## 1.2 PRODUCTS

A. Backdraft Dampers: Suitable for horizontal or vertical installation.

1. Frame: 18-gage galvanized steel, with welded corners.
2. Frame: 0.063-inch-thick 6063T extruded aluminum.
3. Blades: 0.025-inch-thick roll-formed aluminum.
4. Blades: 0.050-inch-thick 6063T extruded aluminum.
5. Blade Seals: Felt.
6. Blade Seals: Vinyl.
7. Blade Seals: Neoprene.
8. Blade Axles: Nonferrous.
9. Blade Axles: Galvanized steel.
10. Tie Bars and Brackets: Aluminum.
11. Tie Bars and Brackets: Galvanized steel.
12. Return Spring: Adjustable tension.
13. Chain Operator: 15-foot-long galvanized-steel sash chain and pulley.
14. Wing-Nut Operator: Galvanized steel, with 1/4-inch galvanized-steel rod.

B. Manual Volume Control Dampers: Factory-fabricated multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.

1. Steel Frames: Hat-shaped, galvanized-steel channels, minimum of 16 gage, and with mitered and welded corners. Provide frames with flanges where indicated for attaching to walls. Provide flangeless frames where indicated for installation in ducts.
2. Roll-Formed Steel Blades: 16-gage galvanized steel.
3. Blade Axles: Galvanized steel.
4. Tie Bars and Brackets: Galvanized steel.

C. Damper Control Hardware: Zinc-plated, die-cast core with a heavy-gage dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Provide center hole to suit damper operating rod size. Provide elevated platform for insulated duct mounting.

D. Fire Dampers: UL labeled according to UL Standard 555 "Standard for Fire Dampers."

1. Fire Rating: 1-1/2 or 3 hours, as indicated.

2. Frame: Type A or Type B; fabricated with roll-formed, 21-gage, galvanized steel; with mitered and interlocking corners.
3. Mounting Sleeve: Factory-installed or field-installed, galvanized steel.

   a. Minimum Thickness: 0.056-inch (16-gage) or 0.138-inch (10-gage) thick as indicated, and length to suit application.
   b. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of the wall or floor, and thickness of damper frame meets sleeve requirements.

4. Mounting Orientation: Vertical or horizontal as indicated.
5. Blades: Roll-formed, interlocking, 21-gage galvanized steel. In place of interlocking blades, provide full-length, 21-gage, galvanized-steel blade connectors.

6. Horizontal Dampers: Include a blade lock and stainless steel negator closure spring.

7. Fusible Link: Replaceable, 165 deg F or 212 deg F rated as indicated.

E. Ceiling Fire Dampers: UL listed and labeled; comply with the construction details for the tested floor/roof-ceiling assemblies as indicated in the UL Fire Resistance Directory.

1. Frame: 20-gage, rectangular or round, galvanized steel; style to suit ceiling construction.
2. Blades: 22-gage galvanized steel with nonasbestos refractory insulation.

3. Fusible Link: Replaceable, 165 deg F rated.
4. Fusible Link: Replaceable, 212 deg F rated.
5. Fusible Link: Replaceable, 285 deg F rated.

F. Smoke Dampers: UL-labeled according to UL Standard 555S, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems." Combination fire and smoke dampers shall also be UL-labeled for 1-1/2 hour rating according to UL Standard 555 "Standard for Fire Dampers." Refer to the Smoke Damper Schedule at the end of this Section for leakage classification, temperature category, and other characteristics.

1. Fusible Link: Replaceable, 165 deg F or 212 deg F rated as indicated.
2. Frame and Blades: 16-gage galvanized steel.
3. Mounting Sleeve: Factory-installed, 18-gage galvanized steel; length to suit wall or floor application.

G. Actuators: Provide motors for smooth modulating or 2-position action.

1. Permanent-Split-Capacitor or Shaded-Pole Motors: Provide with oil-immersed and sealed gear trains.
2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 inch-pounds and breakaway torque rating of 150 inch-pounds.
3. Outdoor Motors and Motors in Outside Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
4. Non-Spring Return Motors: For dampers larger than 25 square feet, size motor for running torque rating of 150 inch-pounds and breakaway torque rating of 300 inch-pounds.

5. 2-Position Motor: 115 V, single phase, 60 Hz.
6. 2-Position Motor: 230 V, single phase, 60 Hz.
7. 2-Position Motor: 230 V, 3 phase, 60 Hz.
8. 2-Position Motor: 460 V, 3 phase, 60 Hz.
9. Modulating, Spring Return Motor: 115 V, single phase, 60 Hz.
10. Modulating, Spring Return Motor: 230 V, single phase, 60 Hz.
11. Modulating, Spring Return Motor: 230 V, 3 phase, 60 Hz.
12. Modulating, Spring Return Motor: 460 V, 3 phase, 60 Hz.

H. Turning Vanes: Fabricate turning vanes according to SMACNA HVAC Duct Construction Standards, Figures 2-2 through 2-7.

1. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.
2. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

I. Duct-Mounted Access Doors and Panels: Refer to the Access Door Materials Schedule at the end of this Section for frame and door thickness, number of hinges and locks, and location of locks. Provide construction and airtightness suitable for duct pressure class.

1. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
2. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.
3. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
4. Insulation: 1-inch thick fiber glass or polystyrene foam board.

J. Flexible Connectors: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.

1. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

2. Conventional, Indoor System Flexible Connectors Fabric: Glass fabric double coated with polychloroprene.

   a. Minimum Weight: 26 oz. per sq yd.
   b. Tensile Strength: 480 lb per inch in the warp and 360 lb per inch in the filling.

3. Conventional, Outdoor System Flexible Connectors Fabric: Glass fabric double coated with DuPont's HYPALON or other synthetic-rubber weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.

   a. Minimum Weight: 26 oz. per sq yd.
   b. Tensile Strength: 530 lb per inch in the warp and 440 lb per inch in the filling.

   c. High-Temperature System Flexible Connectors: Glass fabric coated with silicone rubber and having a minimum weight of 16 oz. per sq yd and tensile strength of 285 lb per inch in the warp, and 185 lb per inch in the filling.

   d. High-Corrosive-Environment System Flexible Connectors: Glass fabric coated with a chemical-resistant coating.
   e. Minimum Weight: 14 oz. per sq yd.
   f. Tensile Strength: 450 lb per inch in the warp and 340 lb per inch in the filling.

K. Flexible Ducts: Comply with UL 181, Class 1.

1. Flexible Ducts - Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.
2. Flexible Ducts - Uninsulated: Corrugated aluminum.
3. Flexible Ducts - Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-thick, glass fiber insulation around a continuous inner liner.

   a. Reinforcement: Steel-wire helix encapsulated in the inner liner.
   b. Outer Jacket: Glass-reinforced, silver mylar with a continuous hanging tab, integral fiber glass tape, and nylon hanging cord.
   c. Outer Jacket: Polyethylene film.
   d. Inner Liner: Polyethylene film.

L. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness.

M. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch; zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

N. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.

O. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

1.3 EXECUTION

A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.

B. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.

C. Provide test holes at fan inlet and outlet and elsewhere as indicated.

D. Install fire and smoke dampers according to the manufacturer's UL-approved printed instructions.

E. Install fusible links in fire dampers.

F. Label access doors according to Division 15 Section "Mechanical Identification."

END OF SECTION 23 3300

# SECTION 23 3423 - HVAC POWER VENTILATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:
   1. Ceiling mounted fans.
   2. Propeller fans.

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on 800 feet above sea level.

B. Operating Limits: Classify according to AMCA 99.

### 1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Fan speed controllers.

B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. 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.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Greenheck
2. Twin City
3. Loren Cook
4. Penn Barry

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. Motors:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated in the schedule on the Drawings. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Controllers: Refer to the schedule on the Drawings and to other Division 23 Sections for requirements for enclosed controllers and variable frequency controllers.

c. Electrical Devices and Wiring: Comply with requirements for electrical devices and connections specified in Division 26.

2. Enclosure Type: Open drip proof (ODP) or totally enclosed, fan cooled (TEFC).

D. Grille: Plastic louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Isolation: Blower and motor shall be mounted on rubber isolators that isolate them from the fan housing.

G. Accessories:

1. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manufacturer's standard wall cap, and transition fittings.

H. Controls: Refer to Division 23 Sections “Automatic Temperature Control for HVAC” and “Sequence of Operation for HVAC Controls” for requirements.

I. Capacities and Characteristics: Refer to the schedule on the drawings.

## 2.3 CENTRIFUGAL ROOF VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one- piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.

2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

3. The motor, bearings, and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blade.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings

3. Pulleys: Cast-iron, adjustable-pitch motor pulley

4. Fan and motor isolated from exhaust airstream

E. Accessories:

1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable, 1/2 inch mesh, aluminum or brass wire

3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops

a. Locate dampers upstream in roof curbs

F. Roof Curbs: 16 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

G. Capacities: As indicated on Mechanical Drawings.

## 2.4 EXHAUST FAN OPERATION

A. General exhaust fans shall operate on an adjustable 7-day Time-of-Day schedule provided by the lighting control system. Fans shall be scheduled to operate with building occupancy.
1. EF-1

B. Cabinet Exhaust Fans shall operate on an occupancy sensor:
1. EF-2
2. EF-3

# PART 3 – EXECUTION

## 3.1 INSTALLATION

A. Support units using elastomeric mounts having a static deflection of 1 inch. Vibration- control devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

B. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 23 3416

# SECTION 23 3713 - DIFFUSERS, REGISTERS, AND LOUVERS

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Linear slot diffusers.
4. Modular core supply grilles.
5. Adjustable side wall registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURERS

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

1. Titus
2. Nailor
3. Price
4. Kreuger
5. Metalaire

### 2.2 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Size: 24 by 24 inches (600 by 600 mm).
5. Face Style: Plaque Face.
6. Mounting: Surface or T-bar to match ceiling type.
7. Pattern: Adjustable.
8. Dampers: None.
9. Accessories:

## 2.3 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material - Shell: Steel, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked white enamel, black.
5. Slot Width: 1 inch (19 mm).
6. Number of Slots: Two as indicated.
7. Length: as indicated on drawings.

## 2.4 REGISTERS AND GRILLES

A. Adjustable Side Wall Register:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
4. Core Construction: Removable.
5. Rear-Blade Arrangement: Horizontal spaced 3/4 inch (19 mm) apart.
6. Frame: 1-1/4 inches (32 mm) wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade.
9. Accessories:
   a. Front-blade gang operator.
   b. Filter.

## 2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

# PART 3 – EXECUTION

## 3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

## 3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. 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. Make final locations where indicated, as much as practical. 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.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

## 3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

# SECTION 23 5400 - FURNACES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:
   1. Gas-fired, non-condensing, and Gas-fired, condensing furnaces and accessories complete with controls.
   2. Air filters.
   3. Thermostat.

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on 800 feet above sea level.

B. Operating Limits: Classify according to AMCA 99.

### 1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Electric heater capacity
   6. Electric power requirements and characteristics.

### 1.5 QUALITY ASSURANCE

A. 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.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver furrances as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Manufacturer's Warranty: Provide the manufacturer's standard written warranty against defects in materials and workmanship. Do not void manufacturer's warranty by installation practices unacceptable to the manufacturer.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fails in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Final Completion:

a. Furnace Parts: Five (5) years.

C. Contractor's Warranty: The Contractor is responsible for the complete installation of the new furnace in a manner that will preserve the manufacturer's warranty. The Contractor will submit a written and signed warranty, in which Contractor agrees to repair or replace the furnace and associated installation materials that are defective in materials or workmanship related to installation of the furnace for a period of one (1) year from the Date of Final Completion.

1. Any corrective work to maintain the performance in this warranty will be carried out by the Contractor at no cost to the Owner.

2. Warranty period: One (1) year from Final Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; Div. of United Technologies Corp.
2. York, a Johnson Controls Company
3. Trane; a business of American Standard Companies.

B.

## 2.2 ELECTRIC FURNACES

A. Factory assembled, piped, wired, and tested.
   1. Cabinet: Steel with glass-fiber interior insulation.
   2. Fan: Centrifugal, direct drive.
   3. Fan Motors: Variable speed
   4. Heaters: Helix-wound, nickel-chromium wire.
   5. Heater Control: Sequencer relay with relay for each element.

B. Controls: Include components required for satisfactory operation of furnaces and auxiliary equipment in all seasons.

   1. Control Transformer: 24 VAC output, factory installed, and wired in furnace.
   2. Thermostat 24 VAC, solid-state, programmable, microprocessor-based wall mounting unit with automatic switching from heating to cooling, preferential rate control, multiple temperature presets selectable by day and time, and battery back-up protection of program settings against power failure.
   3. Relays: As required to achieve specified operation.
   4. Wire and Cable: Specified in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

C. Filters: 1-inch- (25-mm-) thick, disposable, fiberglass type in sheet metal rack.

D. Evaporator Coil: Conform to ARI 210/240, "Unitary Air Conditioning and Air Source Heat Pump Equipment." Match size with furnace. Match remote condensing unit specified in Division 23 Section "Packaged Compressor and Condensing Units" with type, capacity, pressure-drop ratings, restricted distributor, or expansion valve. Include condensate drain pan with accessible drain outlet.

E. Evaporator Coil Enclosure: As required to suit furnace and cooling coil. Steel cabinet with access panel and flanges for integral mounting at or on furnace cabinet.

F. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; with insulated suction line and flared fittings at evaporator end; no fitting at condenser end; length as required.

# PART 3 – EXECUTION

## 3.1 INSTALLATION

A. Install furnaces and accessories according to manufacturer's written instructions.

B. Install and connect gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's published installation instructions.

1. Vents, Outside-Air Pipe Connections, and Drains: Where polyvinyl chloride (PVC) piping is used, install according to Division 23 Section "Common Work Results for HVAC." Install vent terminal designed to protect against birds, insects, and dirt.

2. Connect condensate drain pans using copper tubing, ASTM B 88, Type M (ASTM B 88M, Type C) with streamline drainage fittings and soldered joints or PVC drainage piping. Extend to nearest equipment drain or floor drain. Construct vented, deep trap at connection to drain pan and install cleanouts at changes in direction. Terminate to suit local code requirements, except where stricter methods are indicated.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base where installation conditions require.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.

E. Control Wiring: Install control wiring as specified in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

F. Connect ducts according to Division 23 Section "Metal Ducts."

G. Identify furnaces and connections according to Division 23 Section "Common Work Results for HVAC."

H. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Refrigerant Tubing: Conform to applicable requirements of Division 23 Section "Refrigerant Piping." Connect refrigerant tubing to coils and condensing units.

I. Electrical: Conform to applicable requirements of Division 26 Sections.

1. Install electrical devices provided with furnace but not specified to be factory mounted.

J. Connect motors and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2

END OF SECTION 23 5400

# SECTION 23 8126 – SPLIT SYSTEM AIR CONDITIONERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes evaporative condensers.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 15 Section "Hydronic Piping" for equipment piping requirements.
2. Division 15 Section "Vibration Control" for equipment vibration isolation requirements.
3. Division 15 Section "Condenser Water Treatment System" for chemically treating the unit's recirculated water.

### 1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each unit, including rated capacities, pressure drop, fan performance data, weights (shipping, installed, and operating), installation instructions, and startup instructions.

C. Shop drawings for each unit, indicating dimensions, weight loadings, weight distribution, and clearances required around and between construction elements such as beams, columns, and walls.

D. Coordination drawings indicating structural supports, piping rough-in requirements, wiring rough-in requirements (determine spaces reserved for electrical equipment), and access requirements around other work (including working clearances to mechanical controls and electrical equipment).

E. Wiring diagrams for power supply wiring to equipment and ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between factory-installed and field-installed wiring.

F. Maintenance data for each unit, including parts lists for unit coil, water distribution system, pump, fans, bearings, fan drives, vibration isolators, controls, basin heaters, and all accessories.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully installed evaporative condensers similar in design, size, and extent to those indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications: Firm experienced in manufacturing evaporative condensers similar to those indicated for this Project and with a record of successful in-service performance.

C. Manufacturer Certification: Certify unit's capacity in writing, based on factory performance tests.

D. ASME Compliance: Comply with ASME 1992 "Boiler and Pressure Vessel Code," Section VIII, Division 1, "Basic Coverage" for constructing and testing condenser pressure vessels. Stamp with ASME mark.

E. NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Protect units from damage during shipping and handling with factory packaging.

B. Site Acceptance: Reject damaged units upon arrival. Do not install damaged units or components. Replace with new ones.

C. Rigging: Rig units for unloading and moving as recommended by the equipment manufacturer.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering units that may be incorporated in the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide units by one of the following:

1. Baltimore Aircoil Company, Inc.
2. Evapco Inc.
3. Recold, A Division of the Marley Cooling Tower Company.

2.2 COMPONENTS

A. Coil: Steel surface, designed for low pressure drop and free drainage of liquid, hot-dip galvanized after fabrication. Pressure test coils at 350 psig (2412 kPa) air under water.

B. Drift Eliminator Material: Formed PVC; resistant to rot, decay, and biological attack; with a maximum flame spread rating of 5 per ASTM E 84.

C. Drift Eliminator Material: Hot-dipped galvanized steel with polymer coating.

D. Drift Eliminator Material: Galvanized steel conforming to ASTM A 525 (ASTM A 525M), Coating Designation G 210 (Z 600).

E. Drift Eliminator Material: Stainless steel.

F. Hot Water Distribution System: Ensures even distribution of water over fill.

1. Piped Distribution Manifold: Galvanized-steel pipe header and removable, galvanized-steel pipe branches, or Schedule 40 PVC pipe header and removable, Schedule 40 PVC pipe branches.
2. Piped Distribution Manifold: Galvanized-steel pipe header and removable, galvanized-steel pipe branches.
3. Piped Distribution Manifold: Schedule 40 PVC pipe header and removable, Schedule 40 PVC pipe branches.
4. Nozzles: Removable plastic, brass, or ceramic nozzles.

G. Inlet Screen: Galvanized-steel mesh, hot-dipped galvanized steel mesh with polymer coating, or stainless-steel mesh; mounted on removable frame.

H. Inlet Screen: Galvanized-steel mesh mounted on removable frame.

I. Inlet Screen Material: Hot-dipped galvanized-steel mesh with polymer coating mounted on removable frame.

J. Inlet Screen Material: Stainless-steel mesh mounted on removable frame.

K. Basin Heaters: Sized to maintain basin water temperature at 40 deg F (5 deg C) when ambient temperature is 0 deg F (minus 15 deg C) and wind velocity is 10 mph (16 km/h).

L. Heater: Hot water; entering temperature 180 deg F (85 deg C).

M. Heater: Steam; minimum pressure of 5 psig (35 kPa).

N. Heater: Electric immersion heaters with thermostat and low-water cutout, enclosed in weatherproof housing suitable for field wiring.

O. Circulating Pumps: Centrifugal, close-coupled, bronze-fitted, with mechanical seal; mounted vertically to drain completely when unit pan is drained and piped to spray header and suction strainer.

P. Water Level Control: Standard mechanical makeup water valve and a plastic or bronze float with an adjustable linkage.

Q. Water Level Control: Electric float switch, characteristics coordinated with the supplier of the solenoid-operated, makeup water valve.

R. Water Level Control: Electric float switch and solenoid makeup valve.

S. Fan: Propeller.

T. Fan: Centrifugal.

U. Fan: Propeller or centrifugal.

1. Bearings: Self-aligning ball bearings or bronze sleeve bearings, with external, extended grease lines and fittings.
2. Blade: Cast aluminum with adjustable pitch.
3. Blade: Cast aluminum with fixed pitch.
4. Blade: Galvanized steel with fixed pitch.
5. Drive: Gear drive with speed reducer.
6. Drive: Belt drive.
7. Drive: Gear drive with speed reducer or belt drive.
8. Motor: Open, dripproof, energy-efficient motor conforming to NEMA MG 1.
9. Motor: Totally enclosed, fan-cooled, energy-efficient motor conforming to NEMA MG 1.
10. Motor: Totally enclosed, air-over, energy-efficient motor conforming to NEMA MG 1.
11. Motor Speed: Single speed.
12. Motor Speed: Two speed.
13. Motor Speed: Single speed, suitable for a variable-speed drive.
14. Vibration Cutout Switch: De-energizes fan motors if excessive vibration occurs due to fan imbalance.

V. Discharge Dampers and Controls: Galvanized steel with airfoil capacity control dampers, linkages, electric damper operator, controller, end switches, transformer, and weatherproof enclosure.

## 2.3 FABRICATION

A. Fabricate evaporative condensers using manufacturer's standard design, materials, and construction in accordance with published product information.

B. Configuration: Forced draft.

C. Configuration: Induced draft.

D. Casing Material: Hot-dipped galvanized steel with polymer coating or galvanized steel conforming to ASTM A 525 (ASTM A 525M) Coating Designation G 210 (Z 600).

E. Casing Material: Hot-dipped galvanized steel with polymer coating.

F. Casing Material: Galvanized steel; conforming to ASTM A 525 (ASTM A 525M). Coating designation G 210 (Z 600).

G. Casing Material: Stainless steel.

1. Fasteners: Corrosion resistance equal to or better than the materials being fastened.
2. Seal all joints watertight.
3. Make welded connections continuous and water tight.
4. Rigging supports allow handling evaporative condensers at construction site.

H. Collecting Basin: Galvanized steel conforming to ASTM A 525 (ASTM A 525M), Coating Designation G 210 (Z 600) hot-dipped galvanized steel with polymer coating.

I. Collecting Basin: Galvanized steel conforming to ASTM A 525 (ASTM A 525M), Coating Designation G 210 (Z 600).

J. Collecting Basin: Hot-dipped galvanized steel with polymer coating.

K. Collecting Basin: Stainless steel.

1. Removable basin strainer with openings smaller than nozzle orifices.
2. Overflow connection.
3. Makeup water connection.
4. Oversized drain connection for a remote sump.
5. Side drain connection.
6. Bottom drain connection.

L. Vibration Control: Direct isolation (no base) and vibration isolators recommended by manufacturer.

M. Vibration Control: Direct isolation (no base) and the following vibration isolators as referenced in Chapter 42 of the 1991 ASHRAE "Handbook--Heating, Ventilating, and Air-Conditioning Applications":

1. Vibration Isolators: Rubber mounts (Type 2), minimum deflection of 0.25 inch (6 mm).
2. Vibration Isolators: Restrained-spring isolators (Type 4), minimum deflection of 0.75 inch (19 mm).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting unit performance. Examine proposed route of moving

equipment into place and verify that it is free of interferences. Verify piping rough-in locations. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Final locations of equipment on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.

## 3.2 INSTALLATION

A. Install equipment according to manufacturer's written instructions.

B. Install and anchor equipment plumb and level.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install vibration isolators according to isolator manufacturer's recommendations.

E. Install flexible pipe connections for units mounted on vibration isolators.

F. Install piping connections, maintaining clearances for service and maintenance of equipment.

G. Install flanged or union connections at evaporative condenser.

H. Pitch piping down to drain into sump.

I. Install shutoff valves at inlet and outlet connections.

J. Connect overflow drain and bleed lines to storm drainage system.

K. Connect overflow drain and bleed lines to sanitary sewage system.

L. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted, such as remote, electronic water-level controller; equipment control panel; and remote, basin-water-heater control panel. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide a factory-authorized service representative to supervise the field assembly of components and installation of units, including piping and electrical connections, and to report results in writing.

## 3.4 DEMONSTRATION

A. Startup Services: Provide a factory-authorized service representative to start up service and to demonstrate and train Owner's maintenance personnel on procedures and schedules related to startup, shutdown, troubleshooting, servicing, and preventive maintenance.

## 3.5 CLEANING

A. Clean units using materials and methods recommended by manufacturer.

B. Clean finishes to remove dust and dirt.

C. Touch up scratches on unfinished surfaces to restore corrosion resistance.

D. Touch up scratches on finished surfaces to restore finish.

## 3.6 COMMISSIONING

A. Operate equipment controls and safeties.

B. Lubricate rotating parts.

C. Verify fan rotation direction.

D. Verify that motor amperage complies with manufacturer's data.

E. Adjust water level control for proper operating level.

END OF SECTION

# SECTION 238128 – DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

## PART 1 - GENERAL

### 0.1 RELATED DOCUMENTS

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

### 0.2 SUMMARY

A. Types of indoor system units specified in this section include the following:

1. Outdoor Condensing Units

2. Indoor High Wall Units

B. Refer to Division 26 sections for the following work; not work of this section.

1. Power supply wiring from power source to power connection on Air Conditioning units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

C. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:

1. Interlock and Control wiring between field-installed controls, indicating devices, and unit control panels.

D. Related Sections:

1. Section 23 05 03 “Submittals for HVAC”.

### 0.3 QUALITY ASSURANCE

A. Test and rate systems in accordance with ARI 210/240.

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. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

E. The outdoor unit will be factory charged with R-410A.

0.4 INSTALLATION REQUIREMENTS

A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. Untrained contractors who wish to bid this project will have to contact their local representation to arrange training prior to bid day.

0.5 WARRANTY

A. Unit Warranty: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or 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. Warranty shall include all parts and labor.

B. Warranty Period: 5 years from date of owner acceptance.

0.6 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for AC unit:

1. 1 set filters for each unit.

PART 2 - PRODUCTS

0.1 MANUFACTURER

A. Subject to compliance with requirements, provide ductless split system air conditioning units of one of the following manufacturers:

1. Daikin

2. Mitsubishi

3. LG

0.2 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 and will calculate how much additional refrigerant is 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. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

8. 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.

| Operation Sound (dB) | Night Mode<br>Sound Pressure Level (dB) |
|---|---|
| Step 1 max. | 55 |
| Step 2 max. | 50 |
| Step 3 max. | 45 |

D. Compressor

1. The inverter scroll compressors shall be variable speed (PVM inverter) 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.

2. 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.

3. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

4. The capacity control range shall be 4% to 100%.

5. Oil separators shall be standard with the equipment together with an intelligent oil management system

6. Compressor assembly shall be installed on spring or rubber vibration isolators and shall have internal spring isolation.

7. Compressors shall be single-phase or 3-phase a specified on the contract drawings.

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 Hi-X seamless copper tube with N-shape 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; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and 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.

## 0.3 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 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 open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

6. 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.

7. Filters

a. Unit shall have filter track with factory-supplied cleanable filters.

8. Electrical Requirements

a. 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.

9. Special Features (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. (009 size unit) or 3 to 25 ft. (012-024 size units).

b. Condensate Overflow Switch
1) A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.

## PART 3 - CONTROLS

### 0.1 PHYSICAL CHARACTERISTICS:

A. General: The control system shall be a neutral color plastic material. Each control may have a Liquid Crystal Display (LCD.

### 0.2 ELECTRICAL CHARACTERISTICS

A. General: From each circuit board to the controls, the electrical voltage shall be 16 volts DC.

B. 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.

0.3 CONTROLLER CHARACTERISTICS:

A. Local Remote Controller-

1. The Local Remote Controller shall be mounted into a standard 2” x 4” junction box.

2. Unit Display

a. 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.

b. Provide a backlit LCD display with contrast adjustment and auto off after 30 seconds.

c. 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$^{o}$F (0-32$^{o}$C). Detailed display will reflect room temperature (0-176$^{o}$F/-17-80$^{o}$C range in one degree increments). Display of temperature information shall be configurable for Fahrenheit or Celsius.

d. On/Off status shall be displayed with an LED.

e. Error codes will be displayed in the event of system abnormality/error with a two digit code.

f. The following system temperatures can be displayed to assist service personnel in troubleshooting:
1) Return air temperature
2) Liquid line temperature
3) Gas line temperature
4) Discharge air temperature (if available on the unit)
5) Remote temperature sensor temperature
6) Indoor temperature setpoint

3. 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)
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

4. 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 Setback (Heating) 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 + 1°F (0.5°C).
2) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C).

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 either the local controller, the return air temperature sensor mounted in the unit, or a remote temperature sensor.

B. Multi-Zone Controller- Centralized Remote Controller

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 two RJ-45 Ethernet port to support interconnection with a network PC via the internet or Local Area Network (LAN), or connection with a non-networked PC after completed installation

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 individual unit power usage and distribution, Tenant Billing, energy optimization services, 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 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, Dio 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 $60^0$F - $90^0$F ($16^0$C - $32^0$C). Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.

j. Display shall reflect room temperature $0^0$F - $176^0$F ($-18^0$C - $80^0$C) 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 Dio, 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 (0 - $4^0$C) 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 (5 - $35^0$C).
         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 1 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 + $2.7^0$F.
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 - $2.7^0$F.
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.
11) Interlock with other equipment
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.

6. 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.

C. BAS Gateway- BACnet or LonTalk

1. General

a. The Interface for use in BACnet or LonTalk shall provide the gateway for a Building Management System (BMS) to perform all controlling functions related to the spaces served by all indoor and outdoor units. It shall be capable of controlling a maximum of 4 complete systems of 64 indoor unit groups (128 indoor units) connected to a maximum of 10 outdoor units on each system. Each

system is independent of each other and each system will terminate on its own ports.

b. The Interface shall allow the BMS to supersede all of the controlling functions of the local centralized controller, local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. All controlling parameters and logic shall reside in the BMS and shall be accomplished through programming at the BMS front end controllers.

c. The Interface for use in BACnet uses a standard open protocol based on ANSI/ASHREA Standard 135. The BACnet Interface has been certified by the BACnet Testing Laboratories (BTL). The BACnet Interface is compatible with BACnet IP (ISO16484-5). Interfaces that have not been certified by the BACnet Testing Laboratories shall not be acceptable.

d. The interface wiring shall consist of a non-polar two-wire connection to the terminals of the outdoor unit. The Interface shall be wall mounted and is used as a translator between the Building Management System (BMS) and the VRV communication bus to maintain and control the operation of the connected indoor unit(s).

e. The Interface shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the Internet or Local Area Network (LAN). The Ethernet connection shall be capable of transmission on 10Base-T and/or 100Base-TX connection at 100 Mbps.

f. The Interface shall be capable of being configured as a foreign device. It shall be capable of communicating across LonMark certified or BACnet Broadcast Management Devices (BBMD) in different subnet networks.

g. The Interface shall be capable of supporting Change of Value (COV) notification for all available objects.

h. A setup tool shall be available so that certified commissioning personnel/facility staff can securely log into each Interface via a PC to support the configuration and testing of the Interface.

2. Mounting

a. The Interface shall be mounted on the wall or in an enclosure.

3. Display Features

a. The Interface shall be approximately 10.81” x 10.34” in size.

b. LED display provides the interface’s operational status and alarm.

c. The Interface shall be capable of displaying indoor unit objects on the BACnet building management system. It shall provide the building management system the capability to command the setpoint temperature in $1^0$F ($0.1^0$C) increments with

a range of $60^0$F - $90^0$F ($16^0$C - $32^0$C). Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius.

d. The Interface shall provide the BACnet building management system the capability to display the room temperature in $0.1^0$F ($0.1^0$C) increments with a range of -$120^0$F - $180^0$F (-$84^0$C - $82^0$C). Display of room temperature information shall be configurable for Fahrenheit or Celsius.

e. Error codes generated by the indoor units, outdoor units, heat recovery boxes, and remote controllers shall be displayed on the building management system in the event of system abnormality/error. Communication errors between the Interface and the building management system shall be displayed.

4. Basic Operation

a. The Interface will provide up to 28 objects that can be monitored/controlled via the building management system. It shall be capable of controlling up to 64 indoor unit groups (128 indoor units) per port. Expansion modules can be added to increase the number of ports to a total of 4 ports.

b. The Building Management System shall directly control the following group operations:
   1) On/Off
   2) Operation Mode (Cool, Heat, Fan, Auto, and Dry)
   3) Single setpoint setting for Cooling and Heating in the occupied mode
   4) Fan status
   5) Fan Speed
      a) Up to 3 speeds (dependent upon indoor unit type)
   6) Vane directions
   7) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
   8) Filter sign reset for indoor units
   9) Disable the central controller
   10) Forced off of indoor units
   11) Energy saving offset of indoor unit setpoint
   12) Compressor status
   13) Heater status

c. The interface shall be capable of providing battery backup power for up to 3 years in total time for the clock. Settings shall be stored in non-volatile memory.

5. Programmability

a. The building management system is responsible for all weekly schedule settings through its programming and code.
   1) The schedule shall fully control all functions of the indoor unit as listed in the following:
      a) On/Off
      b) Each scheduled event shall specify time and target group.
      c) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) setback setpoint, Setback (Heating) setback setpoint,

Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable.

d) Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied) by Group.

e) An override shall be provided for use enabling indoor unit operation during the unoccupied period by the building management system programming.

2) The building management system shall perform the auto-changeover through its programming.

a) Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow for the optimal room temperature to be maintained by BMS for automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.

b) 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 on the same communication bus to the same outdoor unit in the Heat Pump system or the same heat recovery box in the Heat Recovery system.

c) Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint.

d) Differential is determined and set by the building management system programming.

e) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint. Differential shall be controlled by the building management system programming.

f) The Guard Timer- Upon changeover, the guard timer will prevent another changeover during this period. The Guard timer should be ignored by a change of setpoint manually from the BMS, centralized controller, local remote controller, or by schedule. The guard timer shall be controlled and configured by building management system programming (30 minute minimum recommended).

3) The Interface shall allow the BMS to force a shutdown of associated indoor unit groups.

## PART 4 - EXECUTION

### 0.1 INSPECTION

A. Examine areas and conditions under which air conditioning units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 0.2 INSTALLATION OF INDOOR/OUTDOOR UNITS

A. General: Install units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install exterior units on grade on 4" thick concrete pad.

C. Support: Install exterior units on roof on equipment curb with flashing to roof. Provide curb type and flashing per roofing manufacturer requirements.

D. 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.

E. 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.

F. 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.

G. 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.

0.3 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.

0.4 TRAINING OF OWNER'S PERSONNEL:

A. Provide services of manufacturer's technical representative for 2- day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 238129

# SECTION 26 00 00 - GENERAL ELECTRICAL REQUIREMENTS

## PART 1 – GENERAL

### 1.1 SCOPE

A. The base bid shall include furnishing all materials, labor, tool, equipment and installation of all work required to install complete electrical systems as shown on the plans and outlines in all Division-26 sections.

B. Submittal of a bid indicates that the contractor has visited the site, has examined the drawing/specifications of all trades and has included all required allowances.

C. Contractor shall be designated as the contractor or sub-contractor for that section of work unless specifically stated otherwise.

D. Work includes but is not limited to the following.

1. Selective demolition as shown on the drawings.
2. Providing all new electrical work as required to accommodate new construction.
3. Provide all necessary distribution equipment, conduit and wiring as shown on the drawings.
4. Provide all necessary wiring to all HVAC systems shown on drawings.
5. Provide and install conduit system for HVAC control wiring to be completed by others.
6. Provide all necessary electrical inspections. Inspections for all necessary pool bonding inspections are to be included.

E. The following work is not included under this contract.

1. Painting of any equipment, except as hereinafter mentioned in the specifications or shown drawings.
2. Temperature Control Wiring, except as hereinafter mentioned in the specifications or shown on drawings.

### 1.2 SPECIAL CONDITIONS

A. Owner’s representative or engineer shall be permitted to relocate any fixture, device or equipment outlet prior to installation within a 15-foot limit at no additional change in contract price.

B. The electrical contractor shall complete their work or any part thereof at such time as may be designated by the owner’s representative, so that it can be used for temporary or permanent use. Such use or the system shall not be construed as an acceptance of same by owner.

### 1.3 MATERIALS AND EQUIPMENT

A. Material installed shall be new, full weight, of the best quality. All similar materials shall be of the same type and manufacturer. All materials, apparatus and equipment shall bear the Underwriter's Laboratory, Inc. label where regularly supplied.

B. Contractor is responsible for the safety and good condition of the material and equipment installed until final acceptance by the Owner. Materials shall be stored to prevent damage or weathering prior to installation.

C. When several materials, products or items of equipment are specified by name for one use, the contractor may select any one of those specified and shall include with the bid an Equipment List listing that equipment selected.

D. Bidders may bid on other materials, products or equipment. All material manufacturers listed in the contract documents as an equal shall be equal in quality, performance, aesthetics, and product support (factory and local) to that specified. Other products, material, article, device, fixture or form of construction not mentioned as approved equal must be approved by the Engineer. Request for approval must be made in writing and approved by the Architect ten (10) days prior to bid opening date, and issued by addendum.

E. The responsibility for costs incurred from deviation from the base equipment shall be the equipment supplier and this contractor. Use of any equipment will be considered as a statement that clearances and arrangements have been checked and found satisfactory.

1.4 GENERAL STANDARDS

A. The applicable provisions of the following standards shall govern. All electrical equipment must contain UL label and be manufactured and assembled in the USA.

B. All work shall be installed in strict accordance with the latest edition of all applicable codes including (but not limited to) the following codes and standards.

1. National Electrical Code, NFPA 70.
2. NFPA 70E
3. Life Safety Code, NFPA 101.
4. Other Provisions of NFPA as applicable.
5. Local Electrical Codes.
6. Local utility company requirements.
7. ADA/ADAAG requirements'
8. ASME.
9. Kentucky Building Code.

C. For the purposes of clearness and legibility, drawings are essentially diagrammatic and although size and locations of equipment are drawn to scale wherever possible, Subcontractor shall make used of all data in all of the contract drawings and shall verify this information at building site.

D. The drawings indicate required size and points of termination of conduit and suggest proper routes to conform to the structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of this section to install conduit and equipment in such manner as to conform to

structure, avoid obstructions, preserve headroom and keep openings and passageways clear without further instructions or cost to the Owner.

E. The electrical contractor shall coordinate electrical work with all other trades and locate/install all equipment and devices accordingly. This contractor shall also refer to coordination drawing of the other trades. And mechanical and/or electrical work fabricated or installed before the above referenced coordination with all other trades will be down at the respective contractors' risk.

F. It is intended that all apparatus be located symmetrical with architectural elements and shall be installed at exact height and locations as shown on architectural drawings.

G. The Subcontractor shall fully inform himself regarding all peculiarities and limitations of space available for installation of all work and materials furnished and installed under the contract. The electrical contractor shall exercise due and particular caution to determine that all parts of the installed electrical work are made quickly and easily accessible. Although the locations of the equipment and conduit may be shown on the drawings in certain positions, the electrical contractor shall be guided by the architectural details and conditions existing at the job site, correlating electrical work with that of others. Provide all offsets as required to provide a neat workmanlike arrangement.

H. Immediately upon award of contract and before any work is started, the electrical contractor shall confer with the Engineer's representative concerning the work under these sections.

1.5 PERMITS AND REGULATIONS

A. All electrical materials used in this work and all workmanship tests performed therein, unless otherwise specified shall conform to the latest rules, regulations and specifications of the National Electrical Code, the National Board of Fire Underwriters, local and state codes having jurisdiction and utility company.

B. Any discrepancy between these drawings and specifications and the codes, laws, ordinances, rules and regulations shall be immediately brought to the attention of the Engineer, prior to any installation.

C. This contractor shall obtain and pay for all permits or certificates of inspection and approval required for this branch of the work.

D. Owner shall be furnished with certificates of final inspection and approval prior to final acceptance of this branch of the work.

1.6 SUBMITTALS

A. All items of material and equipment shall be listed on an Equipment List prepared by the Subcontractor and shall be reviewed by the Engineer prior to the start of any work. Submittal shall be provided in a timely manner allowing for long lead items. No item of equipment will be permitted on the site until acceptance of that equipment has been given. Copies of drawings and manufacturer cuts and performance data will be required for approval. Submittals shall be organized in same order as listed in equipment list and include reference to page and paragraph numbers of the specifications and shall be bound

in sets; all sets identical. The subcontractor is not authorized to purchase any material until the shop drawings are approved by the Engineer.

B. Submittals shall clearly indicate sufficient definition so that they can be properly reviewed for compliance with contract documents.

C. See Division 1 Section “Submittals”.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver equipment and material according to factory shipping requirements. Pack components in factory fabricated protective containers. Units shall be delivered in sections of such size as will pass through available openings.

B. Store equipment and materials in clean dry place and protect from weather and construction traffic. When stored inside, do not exceed structural capacity of the floor.

C. Handling and rigging of equipment and products shall be as recommended by the manufacturer. Components and equipment damaged during shipment or handing shall not be installed. Replace and return damaged components to the manufacturer.

1.8 QUALITY ASSURANCE

A. Contractor, if requested, shall demonstrate 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. Contractor shall have a minimum five (5) years experience in the installation of electrical systems similar to the system specified.

C. The quantity or quality level shown or specified shall be the minimum provided or performed. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Should there be a conflict between the plans and specifications, the greater quantity or better quality shall be furnished.

D. Install all equipment and materials in strict accordance with manufacturer’s written instructions.

E. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified by applicable UL standards. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Ensure that sealing grommets expand to form watertight seal.

F. Upon completion of installation of equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct

malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

G. Prior to energizing, check installed wired and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Prior to energizing, test wires and cables for proper phase to phase connections, for electrical continuity and for short-circuits. Ensure that directions of rotation of each motor fulfills requirement.

1.9 SPECIFICATIONS AND TERMINOLOGY

A. Wherever the words “(the) contractor”, “(this) contractor”, (the) subcontractor”, “(this) subcontractor”, “E.C./EC” or similar terms appear in Division 26 specifications or on electrical drawings, it shall refer to the Electrical Contractor (or sub-contractor of the Electrical Contractor where applicable).

B. Wherever the terms “provide”, “to be” or similar terms appear in Division 26 specifications or on electrical drawings, it shall be interpreted to mean that the electrical contractor shall “furnish and install”, including all necessary accessories to render respective work fully operational.

C. Wherever the work “work” appears in Division 26 specifications or on electrical drawings, it shall be interpreted to mean any and all labor, materials, accessories, services, etc. necessary to fulfill project requirements.

D. Wherever the work “flush” appears in Division 26 specifications or on electrical drawings, it shall be interpreted to mean “recessed in respective surface with visible face flush/even with respective surface”.

E. Specifications shall be interpreted in connection with the drawings, and if anything is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work same as though clearly set forth by both. Furthermore, all materials or labor previously required to fully complete the work shall be included in the contractor’s work even though each item necessary involved be no specifically mentioned or shown. Such work and/or materials shall be the same grade or quality as the parts actually specified and shown. Should there be a conflict between the plans and specifications, the greater quantity or better quality shall be furnished.

1.10 TEMPORARY ELECTRICAL SERVICE

A. Unless directed otherwise, the general contractor will pay for all temporary electric usage for all trades during construction.

B. The electrical contractor shall provide and maintain all power lines (including circuit protection, physical protection, grounding, etc.) for temporary purposes (electrical wiring, lighting, etc.)

C. Route all temporary service lines on the site overhead as required so that the work does not interfere with existing site operations or new construction related work of any trade. Unless directed otherwise in field by owner’s representative, all overhead lines shall be at least 18 feet (from the lowest point) above grade/pavement. Coordinate carefully in field prior to installation. All overhead lines shall be properly supported by messenger cable,

shall be physically protected at risers and drops and shall be properly mounted to supporting structures with insulators and drip loops.

D. Make all necessary arrangements with local utility companies for temporary electrical service and pay all associated fees for inspections, connections, initiation, etc.

E. Electrical contractor shall furnish all temporary light (including lamps) and power complete with all wiring and similar equipment as required, for all work on the site and within the affected buildings during the construction period. Feeders shall be properly fused and ground fault protected per NEC and per all authorities having jurisdiction. Feeders and lamps shall be physically protected along their entire length. Temporary branch circuit wiring shall be installed per NEC in each area with outlets on minimum ten-foot centers to accommodate lamps and with receptacles on nominal fifty-foot centers to accommodate extension cords provided by the contractor in need of them.

F. The electrical contractor shall furnish and maintain all lamps required for the duration of the job. Sufficient sockets and circuit capacity shall be provided for all constructions areas. A minimum of 10-foot candles of illumination shall be maintained in all spaces or as required by OSHA. Provide all necessary specialty temporary power and/or supplementary light for all trades requiring same. At the conclusion of the project, all temporary electric service materials shall be removed by the electrical contractor and become the property of same.

1.11 PROJECT CLOSEOUT

A. General
1. Final payment of contract will not be made until receipt, review and acceptance, by the owner's representative, of all documentation defined hereafter.
2. Where applicable, refer to applicable General Conditions and similar sections of the project manual for details on record drawing submittals. In addition to the requirements specified in Division 1 or other applicable project manual sections, include the following as a minimum.
3. Owner shall be furnished with certificate of final inspection and approval prior to final acceptance of this branch of the work.
4. Test all electrical work and ensure that it rings entirely free from ground.
5. At the conclusion of the project when the system is in full operations, the electrical contractor shall make a final balance of circuits. The electrical contractor shall provide necessary labor, metering, etc., to accomplish this task. Provide written documentation.
6. The electrical contractor shall be responsible for the proper instruction of all equipment and systems to the satisfaction of the owner's representative.

B. Maintenance Manuals
1. In addition to the requirements specified in Division 1 or the other applicable project manual sections, include the following.
2. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
3. Manufacturer's printed operating procedures shall include start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.

4. Provide a minimum of three neatly bound (3-ring binder) copies of maintenance and instruction (O&M) manuals, including a parts list pertaining to all equipment furnished and/or installed by the electrical contractor. Submit to owner's representative for review. Manuals shall be bound in hard cover, post type binders. Manuals shall contain the following as a minimum:

   (1) Index, typed at front w/typed tabs for each section; Lists of all material and equipment furnished with name, address and telephone number of vendor;

   (2) Itemized list of each piece of mechanical equipment having electrical connections with circuit and panelboard locations. Also list with each item any related expendable equipment required such as fuse size and type, pilot lights, Cat. No. of magnetic starter overload, etc.;

   (3) Operating Instruction Manuals and Service Manuals for all equipment furnished by the Electrical Contractor;

   (4) A complete set of final approved shop drawings as submitted during construction;

   (5) An itemized list of each fixture type with catalog number of replacement lamps and ballasts.

   (6) A complete spare parts schedule for all components of all equipment furnished and/or installed under this contract; the schedules shall not be factory generic information, but shall be complete and accurate for the equipment actually provided.

   (7) A complete set of detailed wiring diagram and schematic drawings for all components of all systems furnished and/or installed under this contract; the drawing shall not be factory generic information, but shall be complete and accurate for the equipment actually provided.

END OF SECTION

# SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 - GENERAL

### 1.1 HEIGHT OF BOXES

A. Outlet mounting heights as indicated on the plans are approximate for bidding purposes only. The exact mounting height (and locations) of outlets shall be determined in the field with relation to architectural detail and equipment being served. It shall be the responsibility of the electrical contractor to 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.

B. Prior to rough-in, coordinate final mounting heights of all system outlet boxes in field with Owner's representative. Height of boxes dimensioned from ceiling as given above apply to rooms having ceiling 9' or less. In rooms having higher ceilings, these outlets shall be located as directed in the field. Height of boxes from finished floor to center of boxes shall be as follows, unless directed otherwise in field or otherwise noted on electrical plans or architectural plans.

1. Switches
   a. Counter - 3'-8" (verify and match counter receptacle heights)
   b. Elsewhere - 4'-0"

2. Receptacles
   a. Counters - 3'-8" (verify)
   b. Elsewhere - 1'-6" to bottom of box

3. Telephone Outlets/Data Outlets
   a. Desk Phone - 1'-6"
   b. Wall Phone - 4'-0"

4. Starters - 4'-0"
5. Disconnects - 4'-0"
6. Circuit Breaker Panelboards - 6'-0" to top of panel
7. Wall Mounted Light Fixtures - As noted on plans or as directed by Architect
8. Clock Outlets - 1'-0" below ceiling to top of clock (verify)
9. Television Outlets (MATV/CATV) - 1'-6"
10. Desktop/Tabletop/Portable Sets - 1'-6"
11. Wall/Ceiling Bracket Sets - 1'0"
12. Occupancy Sensors
    a. Wallbox Switches - 4'0"
    b. Others - See Mfg. Literature
13. Other Outlets/Fixtures/Equipment - As Directed by Architect

### 1.2 ACCESS DOORS

A. Access doors shall not be used unless special prior written permission is granted from the Owner's representative. All pull boxes, junction boxes, etc. shall be installed in areas which are readily accessible after completion of construction. Pull boxes and junction boxes shall not be installed above gypsum board or similar ceiling systems. Where there is no other

recourse but to provide and access door/panel and where approval of Owner's representative has been obtained, provide all required access door/panels as required for a complete code-compliant electrical installation as defined below.

B. For installation in masonry, concrete, ceramic tile, or wood paneling provide 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors. For gypsum wallboard or plaster provide perforated flanges with wallboard bead. For full-bed plaster applications provide galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

C. Set frames accurately in position and securely attached to supports, with face panels plum and level in relation to adjacent finish surfaces. Adjust hardware and panels after installation for proper operation. Locking devices shall be flush, screwdriver-operated cam locks.

D. Provide factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces. Frames shall be 16-guage, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling. Standard Flush Panel Doors shall be 14-guage steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory applied prime paint. Fire-Rated Units shall be insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

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

1. Bar-Co., Inc.
2. J.L. Industries
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

1.3 ELECTRICAL INSTALLATIONS

A. All electrical work installed in finished areas shall be concealed. All electrical work installed in unfinished areas may be exposed at the discretion of the Owner's representative. Where exposed conduit and boxes are installed in areas which are already finished, such work shall be painted by the electrical contractor to match adjacent surfaces as directed in field.

B. Arrange for chases, slots, and openings in other building components during the progress of construction, to allow for electrical installations. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the work.

C. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible.

D. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components.

E. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

F. Install systems, materials and equipment giving right-of-way priority to systems required to be installed a specified slope.

G. Project the structure, furnishings, and adjacent materials not indicated or scheduled to be removed.

H. Verify all dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed. Where applicable, remove and/or relocated any existing electrical work conflicting with new construction.

I. Branch circuits shall be installed as shown on the plans. The symbols used to indicate the purpose of which the various outlets are intended are identified in the legend. Where outlets are indicated by letters on plans, they shall be controlled by corresponding switches.

J. No wire size smaller than No. 12 shall be used for any branch circuit unless otherwise noted on plans for control circuits. Larger sizes shall be used where required and/or indicated on the plans. Minimum conduit size shall be 3/4".

K. Device or fixture outlets shall not be installed directly back to back, where located on opposite sides of common walls. Outlets shall be offset by at least two feet.

L. All wires shall be run continuous from outlet to outlet and all joints shall be properly spliced. Insulation value of joints shall be 100% in excess of that of the wire. Mechanical wire splicers may be used. Friction and rubber tape shall conform to Federal Specifications HH-T-11 and HH-T-111. Plastic electrical tape shall be Scotch #33 or approved equal. The conductors terminating at each wired outlet shall be left not less than 6" long at their outlet fittings to facilitate installment of devices of fixtures.

M. If during construction if becomes apparent that certain minor changes in layout will effect a neater job or better arrangement, such alterations shall be made a part of the contract. Engineer's review shall be obtained before making such changes.

N. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches will not be permitted on any exposed materials, fixtures or fittings. Inside of panels and equipments boxes shall be left clean.

1.4 COORDINATION

A. Coordination shall commence immediately upon award of contract. Failure of this contractor in coordinating (including providing related information to other trades for review) in a timely manner, shall not result in any subsequent additional reimbursement, special allowances or additional construction time being made for any facet of the project. Any work fabricated or installed before properly coordinating with all other trades will be done at this contractor's risk.

B. Plans are diagrammatic indicating design intent and indicating required size, points of termination and, in some cases, suggested routes, all necessary offsets, etc. All ductwork, piping, conduit, raceways, cable assemblies, etc. shall be run as straight as possible and symmetrical (perpendicular to or parallel with) architectural items. Work installed diagonal to building members shall not be permitted. The contract document drawings are an outline to indicate the approximate location and arrangement of ductwork, piping, equipment, outlets, raceways, cables, etc.

C. The electrical contractor shall work in harmony with all building contractors and sub-contractors, so as not to cause any delays in pouring concrete, building masonry wall, etc. The location of risers and branch conduits are approximate, but owing to the lack of space in some instances, all trades must work in harmony to insure space and satisfactory arrangement for all work to be installed under this contract. The electrical contractor shall consult the Architectural, Plumbing, HVAC and Structural plans in all instances before installing electrical work so that electrical work will not interfere with those branches.

D. This contractor shall participate in coordination efforts and in preparation of coordination drawings prior to fabrication or installation of any equipment, materials, etc. Coordinate actual clearances of all installed equipment. Exact location of electrical outlets, lighting fixtures, conduits, raceways, equipment, cable assemblies, applicable devices, etc. and of mechanical equipment, piping, ducts, fixtures, diffusers, grills, louvers, dampers, etc., shall be coordinated well in advance by all affected contractors so there will be no interferences at installation between the various trades. Ensure that work of all trades, as well as working clearances, in electrical rooms or spaces complies with NEC Article 110.

E. Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with drawings of other trades, this contractor shall work with the trades to correct the conflict while coordinating representative for a final decision as to method of material. Any work installed or equipment placed in position by this contractor creating a conflict shall be readjusted to the satisfaction of the owner's representative at the expense on this contractor.

1.5 IDENTIFICATION

A. General

1. Submit manufacturer's data on electrical identification materials and products. Submit detailed nameplate schedule indicating proposed nomenclature, colors, text heights, fastening methods, etc. If requested by Owner's representative, submit samples of each color, lettering style and other graphic representations required for each identification material or system.
2. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application. Where identification is to be applied to surfaces which require finish, install identification after completion of painting. Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Cable and Conductor Identification

1. Provide manufacturer's standard vinyl-cloth self-adhesive conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification. Provide on all conductors of all systems. All conductors of all systems shall have color coded insulation. All cables of all systems shall have color coded jackets. Match color schemes with marking systems used in existing systems (where applicable), shop drawings, contract documents, and similar previously established identification of project's electrical work. Apply cable/conductor identification of each cable in each box/enclosure/cabinet for cables which are not available with color coded insulation or jackets.
2. The following insulation color code shall be used for power systems and voltage identification. This shall apply to both feeder and branch circuit wiring. Interchange of colors shall no be permitted. The use of scotch color coding tapes for phase identification is not permitted. Branch circuit and feeder conductor insulation shall be color coded throughout entire length.

    a. 208/120V system - Black, Red, Blue and White
    b. Equipment Grounding - Green

3. Engraved Plastic-Laminate Signs

    a. Install signs at locations for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with stainless steel fasteners, except use permanent adhesive where fasteners should not or cannot penetrate substrate.
    b. All equipment and systems identification nomenclature shown on drawings or listed herein is shown for general design and installation reference only. The actual nameplate, etc. nomenclature for the project shall be verified by electrical contractor in field prior to fabrication and where applicable, shall be an extension of existing nomenclature used on the site as determined in field by electrical contractor. Record documents shall be prepared accordingly. Unless determined otherwise in field, provide text matching terminology and numbering of the contract documents and shop drawings.
    c. Unless directed otherwise, provide black face and white core plies (letter color) for normal power applications and red face and white core piles (letter color) for emergency power applications, punched for mechanical fastening except where adhesive mounting is mandatory because of substrate. For healthcare facilities, non-essential equipment shall have black face and white core plies, essential shall have orange face and white core, and critical shall have red face and white core. Provide 1/2" minimum text height for all equipment identification and 1/4" minimum text height for all nameplates with narrative descriptions/instructions. Thickness shall be 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units. As a minimum provide signs for each unit of the following categories of electrical work where such work exists on the project.

        1) Electrical access panel doors.
        2) Starters, disconnects, contactors and control stations.
        3) Panelboards, electrical cabinets and enclosures.
        4) Control panels for all systems.
        5) Electrical switchboards and switchgear (include company name of engineer and installing contractor at all service entrance switchboards).

6) Switch wall plates (via engraving) for all switches that control remote lights of loads.
7) Other similar equipment designated by owner's representative or engineer in field.

1.6 CUTTING, PATCHING AND SEALING

A. General

1. The electrical contractor shall provide all cutting as required for the admission of electrical work unless directed otherwise in field, all related patching and painting (to match surrounding methods, materials and colors) shall be provided by the electrical contractor. Any damage done by this contractor's expense. Perform cutting, fitting, and patching for electrical equipment and materials as required to:

   a. Uncover work to provide for installation of ill-timed work.
   b. Remove and replace defective work.
   c. Remove and replace work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.

2. Upon Written instructions from the owner's representative, uncover and restore work to provide for observation of concealed work by owner's representative or by inspection authority having jurisdiction.
3. During cutting and patching operations, protect adjacent installation (structure, finishes, furnishings, etc.). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
4. Patch surfaces and building components using new materials matching existing materials and using experienced Installers. Refer to Division 1 for definition of experiences "Installer" or determine qualifications as directed in field by owner's representative.
5. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. All materials used for patching shall be installed to meet or exceed the smoke and fire rating of the respective surface being patched.
6. Neatly cut and drill all openings in walls and floors required for the installation. Secure approval of Owner's Representative before cutting and drilling in existing facilities. Neatly patch all openings cut.
7. Cutting and patching shall be held to a minimum by arranging with other contractors for all sleeves and openings before construction is started.

END OF SECTION 26 0500

# SECTION 260508 - ELECTRICAL SITE

## REQUIREMENTS PART 1 - GENERAL

### 1.1 SITE INFORMATION

A. Subsurface conditions may have been investigated during the design of the project. If so, review reports of these investigations. Follow recommendations of these reports.

### 1.2 PROTECTION OF OPEN EXCAVATIONS

A. Protect excavated openings with substantial railings, fencing, signage, shoring, and steel roadway plates in strict compliance with OSHA/NIOSH, with local Department of Transportation (DOT) standards, with authorities having jurisdiction, and as directed by owner's representative in field.

B. Provide traffic detours per DOT standards during active construction work shift time periods.

Provide related barricades, signage, portable flashing lights, etc. (per DOT standards) at specific locations as determined in field.

C. Provide steel roadway plates, properly installed and anchored per DOT standards, over roadway cuts during inactive periods (i.e. between construction work shifts, while concrete is curing, and while flowable backfill is curing).

D. Finish work affecting the roadways, and restore/pave roadway cuts, as quickly as possible after starting those segments of work. Carefully coordinate scheduling for roadway related work to allow adequate time for inspections and curing, while keeping overall related time to a minimum.

### 1.3 PROJECT CONDITIONS

A. Existing Utilities

1. Locate existing underground utilities in excavation areas, which are to remain. Support and protect these services during excavation operations.
2. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
3. Provide temporary utility services to affected areas. Give owner’s representative minimum 48-hour notice prior to utility interruption.

B. Explosives

1. Do not use explosives.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill and Fill Materials

1. Use excavated material for backfill. Prior to backfilling, remove rock and gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetable matter, and other deleterious matter.

B. Nonshrink, Nonmetallic Grout

1. Provide premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout, recommended for interior and exterior applications.

C. Flowable Backfill Material

1. Refer to "CONTROLLED LOW STRENGTH MATERIAL (FLOWABLE BACKFILL)" subsection under Part 3 - Execution below.

D. Subbase

1. Subbase refers to the compacted layer used in pavement systems between the subgrade and the pavement base course material. Provide subbase consisting of graded mixture of crushed gravel, crushed stone, crushed slag, or sand.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

B. Comply with codes in jurisdiction. Provide sloped sides, and shore and brace as required when trenching to achieve stability. Provide excavation and backfilling required for electrical work and consult with utilities prior to beginning excavation. Remove materials of every nature and description encountered in obtaining required lines and grades. Remove excess excavated earth materials from the site.

C. Properly restore streets, sidewalks, concrete and blacktop surfaces that were broken for installing piping.

D. Where subsidence occurs at electrical installation excavations during a period of 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.2 EXCAVATION

A. Shoring and Bracing

1. Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation. Remove shoring and bracing when no longer required.
2. Install sediment and erosion control measures in accordance with local codes and ordinances.

B. Dewatering

1. Prevent surface water, subsurface water, and ground water from flowing into excavations and from flooding project site and surrounding area.
2. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting/run-off areas. Do not use trench excavations as temporary drainage ditches.

C. Material Storage

1. Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees.
3. Remove from site, and legally dispose of, excess excavated materials and materials not acceptable for use as backfill or fill.

D. Trenching

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room.
2. Excavate trenches to depth indicated or otherwise necessary to full project requirements.
3. All trench widths indicated on drawings are minimum required widths.

E. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees Fahrenheit.

F. Backfilling and Filling

1. Place soil materials in layers to required elevations for each area classification listed below, using materials specified in Part 2 of this Section.
2. Backfill excavations as promptly as work permits, but not until completion of the following:

    a. Inspection, testing, and approval.
    b. Recording locations of underground utilities.
    c. Removing concrete formwork.
    d. Curing of concrete.

e. Removing shoring and bracing, and backfilling of voids.
f. Removing trash and debris.

G. Placement and Compaction

1. Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
2. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, that are frozen, that contain frost, or that contain ice.
3. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
4. Compact each layer of backfill or fill material to 95 percent standard compaction.

H. Moisture Control

1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

## 3.3 CONTROLLED LOW STRENGTH MATERIAL (FLOWABLE BACKFILL)

A. Description

1. Controlled-Low-Strength-Material (CLSM) is a material that has a specified compressive strength of 1200 pounds per square inch (PSI) at 28 days. This material is not concrete and is in a flowable state at the time of placement.

B. Materials

1. Provide CLSM mixture consisting of water, Portland Cement (Type I or II conforming to ASTM C-150, Type "F" fly ash, and fine aggregate.
2. If fly ash is not used, provide CLSM using high dosages of an air entraining admixture to help flowability and lower strength for removability.
3. Non-standard materials may be used only after receiving special permission from owner’s representative.
4. Provide water used in mixing and curing that is as clean and free of oil, salt, acid, alkali, sugar, vegetable, and other substances injurious to the finished product as possible. Test water in accordance with the requirements to AASHTO T 26. Water known to be of potable quality may be used without testing.
5. Use fine aggregates conforming to ASTM C 33 in CLSM.

C. Mix Design

1. Provide proportion of materials used in CLSM as follows:

| | |
|---|---|
| Cement: | 50-100 pounds (lbs) per cubic yard |
| (cy) Type "F", Fly Ash: | 250-300 lbs/cy |
| Sand: | 2700-2800 lbs/cy |
| Water: | 400-500 lbs/cy |

2. Other proportions may be used only after receiving special permission from owner's representative.
3. Conform to the following flowability test:

    a. Fill a 3-inch diameter by 6-inch long open ended cylinder with the mixture, then strike off to level. Remove the cylinder by pulling straight up and ensure the diameter of the CLSM, after spreading, is a minimum of 8-inches.

D. Mixing and Transportation

1. Transport CLSM by mixer truck. Provide continuous agitation from mixing to placement.

E. Placement

1. Place CLSM directly from the truck chute or pump it. No additional compaction is required.

## 3.4 PREPARATION FOR TOPSOIL AND SEEDING

A. Separately stockpile excavated topsoil adjacent to the trench and utilize it in the final stage of backfilling operation.

B. Grade exposed earth and other erodible areas to a reasonably uniform, and satisfactory, cross section and slope, as soon as practicable.

END OF SECTION 260508

# SECTION 26 0519 - LOW-VOLTAGE POWER CONDUCTORS AND CABLES

## PART 1 GENERAL

### 1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Install all wire in raceway unless specifically permitted otherwise hereafter in this section under other Division 26 sections or on electrical drawings.

### 1.2 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

### 1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

B. Wires and Cables:

1. Alcan Aluminum Corporation; Alcan Cable Div.
2. American Insulated Wire Corp.; Leviton Manufacturing Co.
3. BICC Brand-Rex Company.
4. Carol Cable Co., Inc.
5. Senator Wire & Cable Company.
6. Southwire Company.

C. Connectors for Wires and Cables:

1. AMP Incorporated.
2. General Signal; O-Z/Gedney Unit.
3. Monogram Co.; AFC.
4. Square D Co.; Anderson.
5. 3M Company; Electrical Products Division.

### 2.2 GENERAL

A. Provide wire and cable suitable for the temperature, conditions and location where installed.

## 2.3 CONDUCTORS

A. Conductor material shall be copper for all wires and cables. Conductor sizes indicated are based on copper. Minimum conductor size shall be #12 AWG. Provide stranded conductors for all sizes unless indicated otherwise.

B. Distances from panel to first outlet of a 15 or 20 amp branch circuit shall require the following minimum wire size to the first outlet. All branch circuits more than 100 feet in length shall be minimum No. 10 to the last outlet. Control circuits shall be No. 14 except for runs exceeding 300 feet where they shall be No. 12.

| (1) Distance | AWG Wire Sizes |
|---|---|
| (2) Up to 100 feet | #12 |
| (3) 100 to 200 feet | #10 |
| (4) More than 200 feet | #8 |

C. Color Coding for phase identification shall be in accordance with Division 26 Section "Common Work Results for Electrical." All conductor insulation shall be rated at 600V AC/ 90 deg. Provide XHHW insulation for all conductors size 250 kcmil (MCM) and larger. For all other sizes provide THW or THHN/THWN insulation as appropriate for the locations where installed.

D. Provide XHHW insulation for all wiring below grade and/or for all wiring subject to moisture conditions.

E. Provide dedicated parity sized neutral conductor for each branch circuit phase conductor that serves H.I.D. luminaires.

F. Provide dedicated parity sized neutral conductor for each branch circuit phase conductor that serves receptacles.

## 2.4 TYPE AC/MC CABLES

A. Type AC cable is not permitted for use on this project.

B. Type MC Cables shall be 90 deg. C. rated with all components and fittings listed for grounding and compliant with the following.

1. UL Std. 4 and UL Std. 83.
2. ANSI E119 and E814.
3. NEC Articles 250 and 333.

C. Cables shall be formed from continuous length of spirally wound, interlocked zinc-coated or glavanized (inside & outside) strip steel. All conductors shall be rated for 90 deg. C. minimum. Provide with full size parity sized green insulated equipment ground condutor.

D. Provide compatible steel fittings with integral red plastic insulated throat bushings, compliant with NEC 350-5.

E. Type MC cable may be utilized only if NEC approved and if approved by local authority having jurisdiction and in the following applications defined below.

1. Final connection to lighting fixtures that are installed in accessible tile ceiling systems.
2. Wiring from fixture to fixture only above accessible ceilings.
3. Behind drywall walls for connection of receptacles.

F. Type MC cable may not be used behind drywall ceilings which are considered inaccessible.

G. MC cable installed in both locations permitted by this section and areas subject to Article 517 requirements, health facilities type MC must be used.

2.5 PORTABLE CORD (if required)

A. Portable Cord shall be Type S. Provide with full parity sized insulated equipment ground conductor.

B. Type S Portable Cord may be used for flexible pendant leads to outlets and equipment where indicated and only where NEC approved, where approved by local authority having jurisdiction and where prior approval is given by Engineer.

2.6 CONNECTORS FOR CONDUCTORS

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Wires #6 AWG and larger shall be connected to panels and apparatus by means of approved lugs or connectors large enough to enclose all strands of the conductors. Connectors shall be of the solderless type. Solderless connectors shall be O.Z. Type XW or XTP of proper size and type required with Bakelite covers and stainless steel spring clips. Solderless lugs shall be O.Z. Type XL of proper size as required.

C. No wire shall be pulled until raceways are complete, plastering is complete and raceways are free of moisture. Joints or splices shall be permitted only at NEC approved panels, junction boxes or accessible outlet boxes. Pull conductors simultaneously where mor e than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary. Use pulling means including, fish tape, cable, rope or basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable. Conceal all work in finished spaces.

D. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

E. Remove existing wires from raceway before pulling in new wires and cables.

F. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

G. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Division 26 Section "Common Work Results for Electrical."

I. Seal around cables penetrating fire-rated elements according to Division 7 Section "Firestopping."

J. Identify wires and cables according to Division 26 Section "Common Work Results for Electrical."

3.2 FIELD QUALITY CONTROL

A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
2. Megger all branch circuits and feeders #6 and larger. Submit results to consulting engineer. Acceptable meg ohm readings shall be per NETA standards.

B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 26 0519

# SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section 0519 "Low-Voltage Electrical Power Conductors and Cables" for requirements for grounding conductors.

### 1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

### 1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Erico Inc.; Electrical Products Group.
2. Galvan Industries, Inc.
3. Ideal Industries, Inc.
4. ILSCO.
5. O-Z/Gedney Co.
6. Raco, Inc.
7. Thomas & Betts, Electrical.

### 2.2 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

## 2.3 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Grounding-Electrode Conductors: Stranded cable.

D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

## 2.4 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.

## 2.5 CONNECTOR PRODUCTS

A. Pressure Connectors: High-conductivity-plated units.

B. Bolted Clamps: Heavy-duty type.

C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

## 2.6 GROUNDING ELECTRODES

A. Grounding Rods: Sectional type; copper-clad steel.

1. Size: 3/4 inch by 120 inches (19 by 3000 mm).

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:

a. Feeders and branch circuits.
b. Lighting circuits.
c. Receptacle circuits.
d. Single-phase motor or appliance branch circuits.
e. Three-phase motor or appliance branch circuits.
f. Flexible raceway runs.
g. Metal-clad cable runs.

2. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-26.

### 3.2 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.

1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.

G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

## 3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both

entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 0526

# SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 WORK INCLUDED

A. Conduit and equipment supports.

B. Fastening hardware.

### 1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, they carry.

## PART 2 - PRODUCTS

### 2.1 MATERIAL

A. Support Channel: Galvanized steel.

B. Hardware: Corrosion resistant.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, beam clamps, spring steel clips.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

D. Do not use powder-actuated anchors.

E. Do not drill structural steel members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance.

1. Use hexagon head bolts with spring lock washers under all nuts.

G. Install freestanding electrical equipment such as switchboards, motor control centers, and transformers on a housekeeping pad, minimum 4" thick and 4" overhang.

H. Install surface-mounted cabinets and panel boards with minimum of four anchors.

1. Provide steel channel supports to stand cabinet 3/4" off wall.

I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panel boards in stud walls.

END OF SECTION 26 0529

# SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:

a. RMC.
b. IMC.
c. EMT.
d. FMC.
e. LFMC.
f. RNC. (PVC)
g. Wireways.
h. Surface raceways.

2. Boxes, enclosures, and cabinets include the following:

a. Device boxes.
b. Outlet boxes.
c. Pull and junction boxes.

B. Related Sections include the following:

1. Division 26 Section 0500 "Common Work Results for Electrical" for raceways and box supports.
2. Division 26 Section 2726 "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

### 1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid nonmetallic conduit. (PVC)

### 1.3 SUBMITTALS

A. Product Data: For raceways, fittings, boxes, and enclosures to be used.

### 1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

B. Comply with NECA's "Standard of Installation."

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Metal Conduit and Tubing:

a. Carol Cable Co., Inc.
b. Cole-Flex Corp.
c. Grinnell Co.; Allied Tube and Conduit Div.
d. Monogram Co.; AFC.
e. Triangle PWC, Inc.
f. Wheatland Tube Co.

2. Nonmetallic Conduit and Tubing:

a. Cantex Industries; Harsco Corp.
b. Hubbell, Inc.; Raco, Inc.
c. Lamson & Sessions; Carlon Electrical Products.
d. Thomas & Betts Corp.

3. Conduit Bodies and Fittings:

a. American Electric; Construction Materials Group.
b. Crouse-Hinds; Div. of Cooper Industries.
c. Emerson Electric Co.; Appleton Electric Co.
d. Hubbell, Inc.; Killark Electric Manufacturing Co.
e. Lamson & Sessions; Carlon Electrical Products.
f. O-Z/Gedney; Unit of General Signal.

4. Metal Wireways:

a. Hoffman Engineering Co.
b. Square D Co.

5. Surface Metal Raceways:

    a. American Electric; Construction Materials Group.
    b. Butler Manufacturing Co.; Walker Division.
    c. Wiremold Co. (The); Electrical Sales Division.

6. Surface Nonmetallic Raceways:

    a. Butler Manufacturing Co.; Walker Division.
    b. Hubbell, Inc.; Wiring Device Division.
    c. Lamson & Sessions; Carlon Electrical Products.
    d. Panduit Corp.
    e. Wiremold Co. (The); Electrical Sales Division.

7. Boxes, Enclosures, and Cabinets:

    a. American Electric; FL Industries.
    b. Butler Manufacturing Co.; Walker Division.
    c. Crouse-Hinds; Div. of Cooper Industries.
    d. Electric Panelboard Co., Inc.
    e. Erickson Electrical Equipment Co.
    f. Hoffman Engineering Co.; Federal-Hoffman, Inc.
    g. Hubbell Inc.; Killark Electric Manufacturing Co.
    h. Hubbell Inc.; Raco, Inc.
    i. Lamson & Sessions; Carlon Electrical Products.
    j. O-Z/Gedney; Unit of General Signal.
    k. Parker Electrical Manufacturing Co.
    l. Robroy Industries, Inc.; Electrical Division.
    m. Thomas & Betts Corp.
    n. Woodhead Industries, Inc.; Daniel Woodhead Co.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: IMC.
2. Underground: RNC(PVC Schedule 40) or IMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT.
2. Concealed: EMT or MC (for receptacles)
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
4. Damp or Wet Locations: IMC.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

   a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
   b. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

6. Connection to light fixtures: Type MC Cable may be used where permitted by code and in lengths no greater than 8'-0" (243 CM) above accessible ceilings.

## 3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 3/4-inch trade size (DN21).

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Support raceways as specified in Division 26 Section "Common Work Results for Electrical."

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tools.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

T. Telephone and Signal System Raceways, 2-Inch Trade Size (DN53) and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-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 at the following points:

1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

V. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

W. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

X. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in a nonmetallic sleeve.

Y. Do not install aluminum conduits embedded in or in contact with concrete.

Z. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

1. Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.
2. Where a surface raceway is used to supply a fluorescent lighting fixture having central-stem suspension with a backplate and a canopy (with or without extension ring), no separate outlet box is required.
3. Provide surface metal raceway outlet box, and the backplate and canopy, at the feed-in location of each fluorescent lighting fixture having end-stem suspension.
4. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, no additional surface-mounted outlet box is required. Provide a backplate slightly smaller than the fixture canopy.

## 3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

## 3.5 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 26 0533

# SECTION 26 0536 - PATHWAYS FOR ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes:

1. Pathways for Telecommunications Systems.

### 1.3 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Store indoors. Unpack and dry wet materials before storage.

### 1.5 DEFINITIONS

A. Pathways: Structures or hardware that provides a permanent and reusable route for housing and the protection of cable media installed between two end points. These structures also provide a permanent enclosure or mechanism that facilitates the addition or replacement of cable over time.

B. Intrabuilding: For horizontal or vertical routing of cable, intrabuilding pathways shall include conduit. Horizontal support hardware is further defined as continuous, (e.g. Conduit) and non-continuous (e.g. J-Hooks, Bridle Rings).

## PART 2 - PRODUCTS – NOT USED

## PART 3 – EXECUTION

### 3.1 TELECOM PATHWAYS INSTALLATION

A. Conduit shall be used in locations where access to cable is unavailable, where portions of the pathway span are inaccessible (i.e. embedded in walls, hard ceilings).

B. Conduits shall not have more than 180 degrees of bends or turns in a segment without the installation of a pullbox.

C. Communication Conduits' fill limitations shall be based on the anticipated cable load, following the fill ratio calculations provided in ANSI/TIA/EIA/569A and the NEC.

D. For hard pan ceiling installation, conduits shall be run continuous from the outlet box to the accessible ceiling where necessary to meet bend radius requirements. They are to be connected to double-gang, deep device boxes (2 1/8 “box with a 1” mud ring), equipped with a single-gang drywall ring at the outlet location.

E. Conduits to Surface Mounted Raceways (SMR) shall be sized to equal the capacity of the SMR channel or cabling capacity. The raceway size of the SMR must be designed to meet the size and number of cables to be installed and include space for the installation of communication outlets. Individual workstation conduits are to be dedicated to only one outlet box each, and shall not be “daisy-chained” together.

F. For drop ceiling installation, conduits should be run continuous from the outlet box to 6 in. above wall with a 90 degree bend, with plastic protective ring. J-Hooks, with the size and number of cables, should be installed at maximum of 3 ft. intervals to support cable to main pathways. They are to be connected to double-gang, deep device boxes (2 1/8 “box with a 1” mud ring), equipped with a single-gang drywall ring at the outlet location. Individual workstation conduits are to be dedicated to only one outlet box each, and shall not be “daisy-chained” together.

G. Surface Mounted Raceways (SMR) shall be sized to equal the capacity of the SMR channel or cabling capacity. The raceway size of the SMR must be designed to meet the size and number of cables to be installed and include space for the installation of communication outlets, with appropriate double-gang, deep device boxes (2 1/8 “box). J-Hooks, with the size and number of cables, should be installed at maximum of 3 ft. intervals to support cable to main pathway.

H. A Pull Box is required each 100 feet, and/or after 180 degrees of directional change has been affected.

I. Non-Continuous Horizontal Cable Support Hardware shall be used in locations where the communication cable is not supported by continuous systems such as cable trays or conduit. Non-Continuous Cable Supports shall be placed not more than 3 feet apart in linear runs.

J. J-Saddle Hooks shall be supported by threaded rod, beam clamps, screwed to existing studding, etc., and can be “ganged” together to provide a number of support way points along a cable route.

K. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables (CAT 6 Augmented); UL Listed. Non-continuous cable supports shall have flared edges to prevent damage while installing cables. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments. Non-continuous cable supports shall be ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.

END OF SECTION 26 0536

# SECTION 26 0548 - VIBRATION CONTROLS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Division 26 Section "Hangers And Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

### 1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

### 1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Welding certificates.

C. Field quality-control test reports.

### 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 VIBRATION ISOLATORS

A. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 0548

# SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Power Raceway Identification Materials
2. Armored & Metal-Clad Identification Materials
3. Power & Control Cable Identification
4. Warning Labels and Signs
5. Instruction Signs

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design this project element, including comprehensive engineering analysis by a qualified design professional, to meet or exceed the program requirements, performance requirements, code compliance, applicable ASTM quality standard, and design criteria as outlined and / or referenced within this RFP package.

### 1.4 SUBMITTALS

A. Not used.

### 1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, all where applicable, shall comply with UL 969.

## PART 2 - PRODUCTS

### 2.1 POWER 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 Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type, panel and circuit numbers.

C. Self-Adhesive 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 adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer, or
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 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 raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type, panel and circuit numbers.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label, or

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

## 2.3 POWER AND CONTROL 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 raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

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.

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

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.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner to engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in compliance with CO-7 DB section 16.

END OF SECTION 26 0553

# SECTION 26 2726 - WIRING DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes various types of receptacles, connectors, switches, and finish plates. Verify color selection with Owner's representative.

### 1.2 SUBMITTALS

A. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

1. Product data for each product specified.

B. Operation and maintenance data for materials and products specified in this Section to include in the "Operating and Maintenance Manual" specified in Division 1.

### 1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Switches: Leviton & Hubbell
2. Dimmers: Lutron
3. Occupany Sensor: Watt Stopper
4. Receptacles: Leviton & Hubbell
5. Wall Plates: Leviton & Hubbell
6. Multi-Outlet Assemblies: Wiremold.

### 2.2 SWITCHES

A. Wall Switches

1. Wall switches, in general shall be flush self-grounding with green ground screw and color coded cover, toggle type, back & side wired, specification grade, rated 20A, 120/277 volts, 1 HP at 120V, A.C quiet type. Locking type switches shall be same as below except with "L" suffix (provide six keys). Catalog numbers below are based on Leviton.

a) Single pole, toggle: CSB1-20G
b) Double-pole, toggle: CSB2-20G
c) 3-way, toggle: CSB3-20G
d) 4-way, toggle: CSB4-20G
e) Double Pole, key lock: 1222-2KL

B. Occupancy Sensor Switches

1. Occupancy sensor lighting swiches for individaul room applications shall be Watt Stopper Inc. #WS-120 or WS-277 series as required. Install these sensors at standard switch heights and locations.
2. Occupancy sensor lighting switches for special applications shall be per the Electrical Legned on the drawings, with power packs, accessories, lenses, mounting, wiring and installation methods as recommended by manufacturer for a complete working installation.

2.3 RECEPTACLES

A. Standard Specification Grade Duplex/Single Receptacles

1. 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, 15-amp and 20-amp, 125-volts, with metal plaster ears, back & side wiring, NEMA configuration 5-15R or 5-20R.
2. Duplex receptacles shall be as listed below.

a) Duplex Receptacle: CR15-GY, CR20-GY
   a. Color: Gray
b) Tamper Resistant: 8200-SGG
   a. Color: Gray
c) Receptacles wired on emergency power shall be red.

B. Ground-Fault Interrupter Specification Grade Receptacles

1. Provide self grounding commercial specification grade, duplex receptacles, ground-fault circuit interrupters; feed-thru type, capable of protecting connected downstream receptacles on single circuit, grounding type UL-rated 943, Class A, Group 1, specification grade, 20-amperes rating (device & feed-thru), 125-volts, 60 Hz; with solid-state ground-fault sensing and signaling (maximum threshold of 5 mA at .025 seconds maximum); equip with 20-ampere plug configuration, NEMA 5-20R. Design units for installation in a 2-3/4-inch (70-mm) deep outlet box without an adapter.
2. Ground fault circuit interrupter duplex receptacles shall be Leviton # 7599-G series.
3. Where GFI protected receptacles are shown on the drawings, provide a separate GFI receptacle for each one shown. Do not feed downstream receptacles from load-side (GFI-protected) terminals of upstream receptacles.

C. Weatherproof cover for exterior receptacle: Leviton 5977-GY

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

D. Protect devices and assemblies during painting.

E. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.

F. Exterior outlets: All exterior outlets shall be of the Ground-Fault Circuit Interrupter (GFCI) Type whether or not they are indicated as such on the drawings. Exterior outlets shall also be provided with a weatherproof cover that is UL listed.

3.2 GROUNDING

A. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.

3.3 FIELD QUALITY CONTROL

A. Testing: Test wiring devices for proper polarity and ground continuity.

B. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.

C. Replace damaged or defective components.

D. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of the equipment being connected.

E. Cord: Rubber-insulated, stranded copper conductors, with type SOW-A jacket. Grounding conductor has green insulation. Ampacity is equipment rating plus 30 percent minimum.

F. Dimmers:

1. Wattage rating exceeds connected load by 30 percent minimum, except as otherwise indicated.
2. Control: Continuously adjustable slide. Single-pole or 3-way switch to suit connections.

3.4 Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:

A. Color: Stainless Steel.

B. Plate-Securing Screws: Metal with heads colored to match plate finish.

C. Material for Unfinished Spaces: Stainless Steel

D. CLEANING

3.5 General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 2726

# SECTION 26 2813 - FUSES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following:

1. Fuses.

### 1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified.

### 1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Cooper Industries, Inc.; Bussmann Div.
2. Gould Shawmut.
3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Contractor is responsible for examining fuse ratings shown on the drawings with actual nameplate requirements on equipment. Install proper fuses according to nameplate data. No additional amounts will be paid for incorrect fuse ratings shown on the plans.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

A. Main Service: Class L, RK1 fast acting.

B. Main Feeders: Class RK1, time delay.

C. Motor Branch Circuits: Class RK5, time delay.

D. Other Branch Circuits: Class RK5, non-time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION 26 2813

# SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Service disconnect switches.
2. Feeder and equipment disconnect switches.
3. Feeder branch-circuit protection.
4. Motor disconnect switches.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section "Fuses" for fuses in fusible disconnect switches.

### 1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.

### 1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer. These devices shall also be the same source as the panelboards.

B. Comply with NFPA 70 for components and installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

B. Manufacturers: Subject to compliance with requirements, provide disconnect switches and circuit breakers by one of the following:

1. Fusible Switches:

a. Siemens Energy & Automation, Inc.
b. Square D Co.
c. Cutler Hammer
d. GE

2. Molded-Case Circuit Breakers:

a. Siemens Energy & Automation, Inc.

b. Square D Co.
c. Cutler Hammer

## 2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.

C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.
2. Kitchen Areas: Type 4X, stainless steel.

## 2.3 ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

E. Circuit Breakers, 400 A and Larger: Field-adjustable, LSI current settings.

F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

J. Shunt Trip: Where indicated.

K. Accessories: As indicated.

L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.
2. Kitchen Areas: Type 4X, stainless steel.

3. Other Wet or Damp Indoor Locations: Type 4.
4. Hazardous Areas Indicated on Drawings: Type 7C.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb.

C. Compare disconnect rating shown on drawing with that required by the actual nameplate data of equipment purchased. Contractor is responsible for installing correct disconnect required by National Electrical Code. No additional compensation will be provided to provide a disconnect which is rated different than what is shown on the drawings.

C. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26 Section "Common Work Results for Electrical."

### 3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

### 3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 26 2816

# SECTION 26 2913 - ENCLOSED CONTROLLERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Multispeed.

### 1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

### 1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

### 1.5 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 – PRODUCTS

2.1 MOTOR STARTERS AND PUSHBUTTONS:

A. For each building utility motor to which the Contractor makes connection and which is not otherwise noted, provide a disconnect switch and magnetic motor starter, separate or in combination as indicated or required. Overload devices must be suitable for protection by a minimum of 15 amp. circuit breaker or fuse. The overload devices in the starters shall be sized to agree with the current rating shown on the motor nameplate.

B. Individual Motor Starters:

1. Individual motor starters shall consist of an integrally mounted, magnetic, full-voltage, non-reversing (FVNR), starter in a heavy-duty type, dead front, sheet steel enclosure, and surface-mounted. Size and number of poles shall be as shown and required by equipment served. All starters shall be constructed and tested in accordance with the latest NEMA standards.
2. Magnetic starter contacts shall be solid silver cadmium oxide alloy, and shall not require any filing, dressing, or cleaning throughout the life of the starter.
3. Operating coils shall be 120 volts, and shall be pressure molded and designed so that accidental exposure to excessive voltage up to 480 volts will not damage the coil. The starter design shall also be such that when a coil fails due to an over-voltage condition, the starter shall definitely open, and shall not freeze in the closed position.
4. All starters shall have manual reset, tripfree overload relays in each phase conductor. Three-phase FVNR starters shall have three overload relays. Single-phase FVNR starters shall have an overload relay in each ungrounded conductor. Overload relays shall not be field-convertible from manual to automatic reset.
5. Provide RUNNING pilot lights for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter, and shall not be wired across the operating coil.
6. Provide starters with HAND-OFF-AUTOMATIC switches (for motors with automatic control), or START-STOP Pushbuttons (for motors with manual controls) as shown or required. Provide for FAST-SLOW speed selection from HVAC control system for all 2-speed starters. All 2-speed starters shall have deceleration relays between FAST and SLOW speeds. Coordinate motor starter controls with the requirements of this Division 15. Motor starter controls shall be mounted in the starter enclosure cover.
7. A single-phase control power transformer shall be included integrally with each starter for 120 or 24 volt control power. The primary shall be connected to the line side of the motor starter; the secondary shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
8. Each starter shall have one normally open and one normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock" and control wiring. In addition, it shall be possible to field-install one or more additional auxiliary contacts without removing existing wiring, or removing the starter from its enclosure.
9. Provide a 3-phase power monitor for each motor starter serving a motor of 20HP or greater. Monitor relay shall drop out upon loss of any phase, undervoltage on any or all phases, or phase reversal from A-B-C sequence. Relay shall be adjustable for trip range and shall automatically reset upon correction of trouble.
10. All motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.

C. Combination Motor Starters:

1. Combination motor starters shall consist of an integrally mounted magnetic starter and a fusible disconnect switch in a heavy-duty type, dead front, sheet steel NEMA 1 (indoor) or NEMA 3R (outdoor), surface-mounted, general purpose enclosures. Size and number of poles shall be as required by equipment served. Combination motor starters shall be as specified for individual motor starters except as modified herein.

D. Disconnect Switch: Disconnect switch shall be as specified in "Safety and Disconnect Switches".

E. Unit Wiring: Unit shall be completely prewired to terminals to eliminate any interior field wiring except for connection of power supply conductors to switch line side terminals, motor leads to the starter load side terminals and control conductors to holding coil terminals.

F. Manual Motor Starters: Manual motor starters shall consist of an integral starter and a manual reset bimetallic trip type thermal overload elements protection in a common enclosure, surface-mounted. Size and number of poles shall be as shown and required by equipment served. Furnish pilot light as needed.

G. Manual motor starter with overload protection, 1 hp maximum, 115 or 230 volts, Square D #FG1-(l) Pole, FG2-(2) Pole; Square D #FG1P-(l) Pole, with pilot light, FG2P-(2) Pole, with pilot light.

H. All manual motor starter enclosures shall be NEMA 1 (for indoor) and NEMA 3R (for outdoor), general purpose enclosures, unless shown otherwise.

I. Manual motor starters to be flush in rooms with finished floors and walls. Provide a stainless steel cover.

2.2 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. Siemens Energy & Automation, Inc.
c. Square D; a brand of Schneider Electric.
d. General Electric

2. Configuration: Nonreversing.
3. Surface mounting.
4. Pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. Siemens Energy & Automation, Inc.
    c. Square D; a brand of Schneider Electric.
    d. General Electric

2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button bimetallic type.
4. Surface mounting.
5. Pilot light.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. Siemens Energy & Automation, Inc.
    c. Square D; a brand of Schneider Electric.
    d. General Electric

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button bimetallic type.
4. Surface mounting.
5. Pilot light.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. Siemens Energy & Automation, Inc.
    c. Square D; a brand of Schneider Electric.
    d. General Electric

2. Configuration: Nonreversing.
3. Contactor Coils: Pressure-encapsulated type.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
6. Melting Alloy Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 10 tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

7. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 10 tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

8. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection.
    b. Sensors in each phase.
    c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

9. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. Siemens Energy & Automation, Inc.
    c. Square D; a brand of Schneider Electric.
    d. General Electric

2. Fusible Disconnecting Means:

    a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J fuses.
    b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

3. Nonfusible Disconnecting Means:

    a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
    b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

4. MCP Disconnecting Means:

    a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.

5. MCCB Disconnecting Means:

    a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

## 2.3 MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    c. Rockwell Automation, Inc.; Allen-Bradley brand.
    d. Siemens Energy & Automation, Inc.
    e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.
3. Contactor Coils: Pressure-encapsulated type.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24 -V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
6. Compelling relays shall ensure that motor will start only at low speed.
7. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
8. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
9. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

10. Melting Alloy Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 10 tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

11. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 10 tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2.4 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

    1. Dry and Clean Indoor Locations: Type 1.
    2. Outdoor Locations: Type 3R.
    3. Kitchen, Wash-Down Areas: Type 4X.
    4. Other Wet or Damp Indoor Locations: Type 4.

2.5 ACCESSORIES

A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.

B. Control Relays: Auxiliary and adjustable time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install fuses in each fusible-switch enclosed controller.

C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

E. Comply with NECA 1.

F. Installation of Motor Starters.

1. Install motor starters where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

2. Install overload heaters in each motor starter. Heater ratings shall be based on actual motor nameplate full load amps.

3. Motor starters shall be provided to properly coordinate with motors as furnished by Division 23. Motor starter controls shall be provided to properly coordinate with controls specified in Division 23.

4. Provide all individual and combination motor starters with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Starters shall not be supported by conduit alone. Where motor starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas. Manual motor starters shall be installed plumb and aligned in the plane of the wall in which they are installed.

G. Motors:

1. Motor Installation and Connections:

a. Motors associated with equipment furnished under other sections of the Specifications will be furnished and installed under the respective section. For such motors, the responsibility under the Electrical Section shall be to provide electrical service and to terminate same adjacent to the associated controller. This termination shall occur in a switch, fused switch, or motor circuit protector as required and/or as shown and noted on Drawings. Electrical service shall also be extended through the associated controller to the motor connector box in flexible conduit.
b. Furnish and install all power wiring and disconnect switches, starters, etc., required for all equipment specified under the "Controls" section of the Mechanical Specifications, whether or not specifically indicated on the Drawings. Circuits shall be run to nearest available 120/208 volt power or motor control panel.
c. Each motor shall be connected to a separate branch circuit except where shown otherwise. Unless otherwise indicated, circuits shall run to the motor via starting equipment and conduit to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible conduit as hereinbefore specified. Ground bond or separate copper conductor shall be made from motor frame to rigid conduit system.
d. Should any equipment and/or motors be furnished requiring electrical service different from that indicated for the equipment and/or motor(s) specified, or electrical connections at more than one point, or at a point different from the one indicated on the Drawings, it will be the responsibility of the Contractor to make the required coordination and changes at no additional cost to the Owner. Refer to Division 23.

2. Motor Control Wiring: Complete motor control wiring shall be provided under the Mechanical Section of these Specifications.

3.2 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

A. Bundle, train, and support wiring in enclosures.

B. Connect selector switches and other automatic-control selection devices where applicable.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

A. Set field-adjustable switches and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

C. Motor Starters:

1. Pre-Energization Check: Check motor starters for continuity of circuits and for short circuits.
2. Post Hook-Up Test: Subsequent to wire and cable hook-ups, energize motor starter and demonstrate satisfactory functioning.

## 3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers

END OF SECTION 26 2913